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fall 1992
International Space Year

from the administrator

Space exploration is a powerful source of inspiration to all of humanity. Viewing our planet from space reminds us that we are one people, one species, inhabiting a spaceship called Earth.

Although International Space Year is drawing to a close, its spirit will endure. ISY has established a worldwide framework that will, as Jean-Marie Luton, head of the European Space Agency stated, "reinforce cooperation well beyond 1992."

Space exploration is a powerful source of inspiration to all of humanity. Viewing our planet from space reminds us that we are one people, one species, inhabiting a spaceship called Earth.

ISY's central research theme of "Mission to Planet Earth" challenges all of us to take responsibility for caring for our common home. What more noble task is there than for the nations of the world to work together, to understand the forces that drive our environment on planet Earth, and to provide our policymakers with real data, enabling them to make decisions based on fact, not speculation? We owe it to our children, and our children's children.

Likewise we owe it to future generations to help build a lasting peace, and NASA and the American space contracting community have been given that opportunity with the signing of a treaty with Russia for joint space ventures. The space program—born out of a competition between our countries for power and survival— will now build bonds for peace as we work together and get to know and understand each other, on a person to person basis.

To illustrate this point, I'd like to share with you an incident that took place when I visited Russia in July.

I was standing in the courtyard of the Zagorsk Monastery, seat of the Russian Orthodox Church. A woman walked up to me and handed me a beautiful pin with a picture of the monastery on it. I offered to give her money for the pin, and unable to speak English, she gestured her refusal to accept it. She asked our interpreter to tell me that I appeared to be a visitor in her country, and she wanted me to have the pin. It looked expensive, and she appeared quite poor, but she was reaching out to me.

I then took my NASA meatball off my coat, and I gave it to her. I explained to her what the meatball was. Tears came to her eyes, and she said she knew all about the American space program. She held onto the pin lovingly and said she was going to give it to her son.

Needless to say, I was really touched. Here was a woman in the heartland of Russia, of little means, and she knew all about America's space program. This type of interaction is what's going to build bonds between our nations.

Daniel S. Goldin

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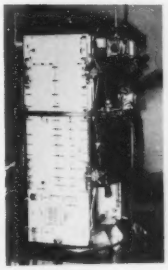

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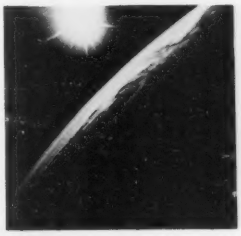

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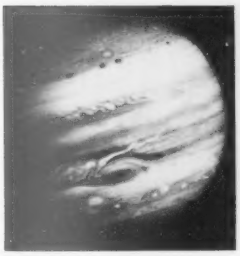

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Cover: Administrator Dan Goldin sits at the Spaceflight Control Center in Russia during his July visit there. Russian Space Agency Director General, Yuri Koptev, is pictured leaning on the console above Goldin. See additional photos of Goldin's trip to Russia on pages 14 & 15, part of the ISY cover story. Cover photo and all photos of Russian trip, courtesy of Bill Ingalls, NASA Headquarters.

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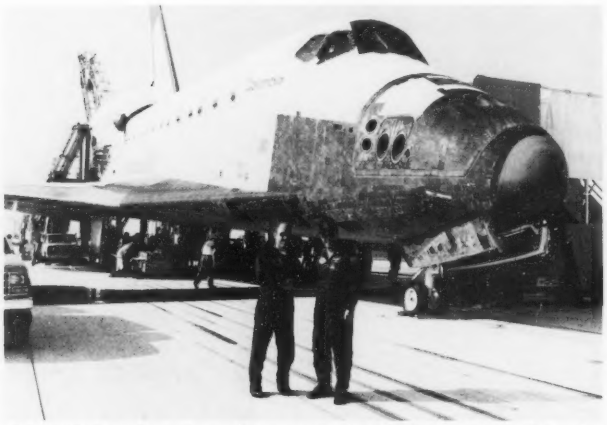


STS-50 Pilot Ken Bowersox and Commander Dick Richards congratulate each other on a job well done after completing a record 14 day Space Shuttle mission.

Hail, Columbia!

Columbia's STS-50 mission this summer set a new Space Shuttle endurance record in orbit: 14 days. The U.S. Microgravity Laboratory mission lifted off at 12:12 pm EDT on June 25 to begin its precedent-making microgravity research flight. The mission had been planned for 13 days, but the STS-50 crew was allowed to extend its orbital stay because of the judicious use of onboard consumables. The crew finally brought Columbia down safely at the Kennedy Space Center on July 9. It was the 10th landing of a Shuttle in Florida and the first for Columbia.

Exploring Poseidon's Realm

NASA's Wallops Island Flight Facility and the Australian Commonwealth Scientific and Industrial Research Organization completed a joint project in mid-July to measure and observe ocean winds, wave heights and wind-wave interaction off the coast of Australia. The observations were taken with instruments mounted on an Australian research aircraft flying at altitudes ranging from 40 feet to 40,000 feet above the waves. These measurements, which were taken in calm seas as well as severe storm and gale conditions, will significantly improve the capabilities of researchers on the Topex/Poseidon mission to understand the transfer of energy from the Earth's winds to ocean currents. The Topex/Poseidon mission, which got underway August 10 with an Ariane launch from Kourou, French Guiana, is a joint NASA-French mission to better understand the role of oceans in global climate change.

In Search of Astronaut Contaminants

Johnson Space Center medical investigators have begun using DNA fingerprinting to investigate the possibility of microbial cross-contamination between astronauts confined within a spacecraft. DNA fingerprinting has been used for the past several years by criminal investigators, but this is its first use in the space program. The technique has allowed Johnson medical scientists to track the transfer of a specific microbe within the Shuttle environment. The results of preliminary investigations also showed that spaceflight did not alter the genetic makeup of the microbe.

Altered States

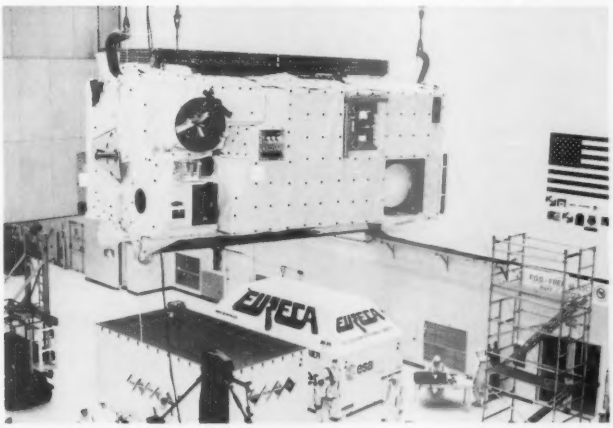
Life science researchers associated with last year's STS-40 Space Life Sciences 1 mission reported in late July on new results of their analyses, which suggest that microgravity during spaceflight produces alterations in cellular metabolism, cell division and cell attachment, and human immune cell function. These changes showed up within only a few days of microgravity exposure. Human immune cells failed to turn into mature cells, which could possibly lead to health problems such as impaired healing abilities or increased risk of infection. Plant cell studies showed that one-third of the chromosomes of the plants flown on the mission had been altered, some in as little as four days. Another important finding was the discovery that the number of synapses used to communicate between the cells of the inner ear's gravity sensing organ and the central nervous system increased 40 percent with no attendant increase in the size of the nerve cells. This finding suggests that nervous systems could easily adapt to changing gravity conditions.

Lessons Learned

The summer's second Shuttle flight began with the liftoff of Atlantis at 9:56 am EDT on July 29. The ambitious mission included deployment of the European-built EURECA carrier and the Italian-built Tethered Satellite. Although EURECA was safely deployed, the tether experiment, designed to study electrical currents generated as the satellite traveled through the Earth's magnetic field, was not successful. Still, the crew was able to gather data about its ability to control the bobbing of the spacecraft in the weightlessness of space. They also learned that the spacecraft remained remarkably stable during retrieval operations. The Atlantis crew landed at the Kennedy Space Center on Saturday, August 8.

Rocky IV Debuts

Jet Propulsion Laboratory robotics engineers demonstrated the latest in their continuing evolution of the "Rocky" series of smart planetary exploration robots on June 26. Rocky IV is a prototype of a mini-rover that could be launched to Mars in 1996 as part of the Mars Environmental Survey Pathfinder mission. The 16.5-pound, six-wheeled robot is two feet long, 15 inches wide and 14 inches high. The robot operated under an autonomous control system that incorporated elements of smart subsystems. The June test was Rocky IV's first in a simulated Martian environment.



The European Retrievable Carrier (EURECA) was deployed during the STS-46 mission in July.

Advance Warning

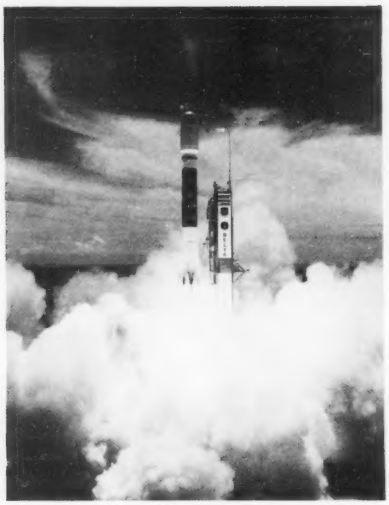
During July and August, Langley Research Center engineers flight-tested three advance-warning windshear sensors in an ongoing effort to develop devices to detect the deadly downdrafts before they cause air crashes. For the first time, the center's 737 research jet carried a laser-based sensor in addition to microwave radar and infrared sensors tested last year. Flight tests were in two stages, with the first occurring in Denver and the second in Orlando.

Fly-By-Computer

NASA researchers "flew" a complete three-dimensional, high-performance aircraft—in a supercomputer—for the first time in July. For the simulation, Yehia Rizk of the Ames Research Center reproduced the complete flow of air around an F/A-18 jet fighter. This achievement was a milestone for the aerospace industry; although computers will never replace wind tunnels, the new technique offers the potential for cheaper aerodynamic research.

Look, Ma, No Pilot

Work began in mid-July on the construction of a very-high-altitude unpiloted research aircraft, which NASA will use to measure ozone levels and collect other atmospheric data. The aircraft is made of lightweight composite materials such as graphite and Kevlar, and is seen as the first step in the general use of advanced aircraft for Earth science research. Many such studies are presently out of the flight regime of the ER-2 high-altitude research aircraft or high-altitude balloons. Called Perseus, the craft is designed to fly nominal missions using a preprogrammed flight sequence with onboard inertial systems using Global Positioning Satellite data and onboard wind sensors to update its autopilot. The plane also can be flown by ground command. Flight testing of the Ames-managed project will begin late this year at the Dryden Flight Research Facility.



The Extreme Ultraviolet Explorer surges skyward atop an Air Force Delta II rocket on June 7.

Extremely Successful Launches

The Extreme Ultraviolet Explorer was launched aboard a Delta II rocket on June 7 at 12:40 pm EDT. In addition to the astronomy observatory, the EUVE spacecraft also carried three piggyback instruments—a first. The EUVE spacecraft is performing an all-sky survey of objects visible only in the extreme ultraviolet.

The Geotail satellite was launched aboard a Delta II at 10:26 am EDT from Launch Pad 17-A at the Cape Canaveral Air Force Station on July 22. Geotail was placed into a highly elliptical orbit of 32,000 by 871,000 miles, where it will remain for its first two and a half years. Then it will be moved to a closer orbit, allowing the instruments to investigate both the near and far magnetic tail regions. This spacecraft is the first in a series of five satellites designed to explore the dynamic relationship between the Sun's solar wind and the Earth's magnetic field. The mission is a joint U.S.-Japanese scientific venture.

The Class of '92

In early August, 24 astronaut candidates arrived at the Johnson Space Center to begin a year of training. In addition to the 15 mission specialist candidates and four pilot candidates, the group includes five international mission specialists.

The foreign candidates include two Canadians, one of them Marc Garneau, who flew on STS-41G, two European Space Agency candidates and one National Space Development Agency of Japan candidate.

The Robot Parade

The largest-ever gathering of interplanetary rovers participated in a robot parade on the Mall in downtown Washington in late August as part of the International Space Year Exhibition of Robots for Exploring New Worlds. The robots ambled from the National Air and Space Museum to a tent about a block away, showing off their finery, as they performed on a 24-by-40 foot section of simulated Martian surface. Among the robots that were on display was one which weighs 4 pounds and another which weighs nearly 3 tons.

Focus on Biomedicine

Officials from NASA and the National Institutes of Health signed an agreement in July to enhance each agency's biomedical research capabilities. The agreement is expected to stimulate new opportunities in the biomedical and behavioral research communities. The agreement calls for joint management and funding of focused, university-based research that can address health and research elements of the human neurovestibular and musculoskeletal systems. NASA and NIH expect that research performed under this agreement will help provide an understanding of how the bone, muscle, vestibular and sensory motor systems function in space crews, and how that knowledge can lead to an understanding of diseases or dysfunctions that can strike these systems. Ultimately, the research is expected to lead to a better understanding of how to counter the effects of debilitating diseases for Earth-bound patients.

Breaking the Ice

Three U.S. scientists, including one from the Ames Research Center, completed the first joint U.S.-Russian Antarctic expedition in late May. The U.S. investigators were Peter Doran of the University of Nevada, Jim Rice of Arizona State University and Dale Anderson, an Ames exobiology support contractor with Lockheed Engineering and Science Company. The purpose of the expedition was to investigate the physical, chemical and biological properties of the ice-covered lakes in the Bunger Hills Oasis located in East Antarctica.

The three U.S. and three Russian scientists traveled to the Oasis aboard a Russian icebreaker. Ames

scientists, including Anderson, have previously studied dry moraine valleys in the McMurdo Sound area because of the possibility that those ice-covered lakes may represent an analog to conditions that may have existed on Mars in the geologic past. This was the first opportunity to examine similar lakes in the Bunger Hills area. The U.S.-Russian team used robots and tethered human divers to examine the lakes.

Teaming Up With Russia

NASA Administrator Daniel Goldin and Russian Space Agency Director General Yuri Koptev formally ratified on June 18 the first contract between NASA and the Russian aerospace firm NPO Energia. The contract calls for the study of applications of Russian space technology to the Space Station Freedom program and covers an initial period of one year with a value of $1 million.

As members of Congress looked on, Administrator Dan Goldin and Russian Space Agency director, Yuri Koptev, shook hands after signing the first contract between NASA and NPO Energia. Pictured standing left to right are, Congressman Dana Rohrabacher, (R-CA); Senator Barbara Mikulski, (D-MD); and Congressman George Brown, (D-CA).

Aiming for the Stars

School has been back in session for several weeks now, but for 95,000 students in Alabama, Mississippi and Tennessee, this year will be different. The NASA Headquarters Bulletin reported that NASA was a catalyst for a major education reform effort that was begun last summer. Dubbed the Tri-State Education Initiative (TSEI), the project encompasses school districts in a 50-mile, three-state area surrounding Iuka, Miss. It's also the first multi-state AMERICA 2000 region in the country.

NASA's National Service Office and the Education Division helped develop the idea for TSEI. Their hope is that the Initiative will evolve into the education system we need to prepare students for the high-tech job market of the 21st century—one of the goals of President Bush's AMERICA 2000 Initiative.

Consortium members, who recently met to develop a strategic plan, see the possibility for real change in the project. All three governors have agreed to waive their state rules and regulations in order to try out some of the demonstration projects that come from the initiative.

The TSEI kickoff ceremony itself served as one such demonstration, linking participants via interactive televideo. With this technology, students and teachers in remote sites could be linked together in a televideo class.

During the ceremony, NASA Administrator Daniel Goldin said the world-class education system that TSEI is designed to create will "help students obtain the skills for the jobs of the future—high-tech and highly competitive.

A Fitting Tribute

One face stood out among the many aerospace scientists at the recent World Space Congress—that of Jet Propulsion Laboratory founder Theodore von Karman, whose visage now graces a commemorative stamp. During the inaugural ceremony of the Congress on August 31, the Postal Service dedicated the 29-cent stamp at the Washington, D.C., Convention Center.

Von Karman exerted enormous influence on America's developing aviation and aerospace industry. His pioneering aerodynamic principles contributed directly to the success of the Apollo program. In 1963, von Karman received the country's first National Medal of Science from President Kennedy.

Credit for the stamp's issue should probably go to University of Southern California professor Shirley Thomas, who wrote a biography of von Karman in 1960. For the past 27 years, she has been lobbying for a stamp in his honor. The von Karman stamp was designed by Connecticut artist Chris Calle, who also designed a Priority Mail stamp for the 20th anniversary of the first manned Moon landing.

Dryden's SR-71 was a popular part of the Oshkosh air show.

Oshkosh, B'gosh!

Well, it just wouldn't be summer without the Experimental Aircraft Association's annual convention and fly-in, better known as Oshkosh. And, it wouldn't be "Oshkosh" without a NASA exhibit. The theme of this year's exhibit was "Exploring New Worlds of Flight," and while space exploration was still a popular subject, NASA's work in aeronautics also played a prominent role.

A steady stream of visitors from morning to night toured the exhibit, where the theme was tied to the 500th anniversary of Columbus' first voyage across the Atlantic. A 50-foot mockup of the Mach 25 X-30, outside the entrance to the pavilion, set the stage for the walking tour inside. Through photos, videos and models, visitors received a comprehensive overview of nearly all of NASA's aeronautical programs—from the Perseus, a remotely piloted craft that will help study ozone depletion and the effects of supersonic transports on the stratosphere, to the X-30, labeled a "Space Age Galleon."

This year's EAA event was the first in a decade to be attended by a NASA administrator. Daniel Goldin held a press conference at the site of the NASA exhibit, and addressed the crowd at a special dinner held on the EAA grounds to commemorate the 75th anniversary of the Langley Research Center.

To LASER from Lockheed

On July 18, Lockheed Missiles and Space Company presented Marshall Space Flight Center Director Jack Lee with a check for $50,000, the first installment in Lockheed's contribution of $125,000 toward the operation of the LASER Mobile Teacher Resource Center. Lockheed's contribution makes the tenth and final contribution needed to reach Marshall's goal of funding the unit for three years.

Compton Sheds Light on Flares

In July, astronomers announced that data from the Compton Gamma Ray Observatory revealed new details about solar flares. Flares are intense eruptions of energy that leap millions of miles from a star's surface, following lines of magnetic force. On the Sun, these eruptions can affect the Earth's weather and disrupt communication and power systems. After one such solar flare, Compton found an unexpected gamma-ray "afterglow." This strong emanation of high-energy radiation lasted more than five hours after the flare subsided.

When it is not flaring, the Sun does not emit gamma rays. According to Dr. James Ryan, one of Compton's principal investigators, "This is an unprecedented effect. We've never seen the Sun glow in gamma rays for such a long time."

A Real Lifesaver

Today's well-dressed Eskimo is wearing not only the layered look, but also a new piece of gear—a lightweight emergency beacon designed by NASA. The beacon is intended to save the lives of thousands who trek through isolated wilderness. For the next three years, 20 Alaskans will carry Personal Locator Beacons (PLBs) with them into the North Slope Borough, one of the state's most remote areas. The PLBs communicate by radio with a 10-year-old search and rescue satellite system used primarily by aircraft and ships.

Through this experiment, researchers hope to prove that personal emergency beacons are useful and necessary. Wayne Hembree, Search and Rescue Mission Manager at the Goddard Space Flight Center says, "Use of the beacons by people in remote areas undoubtedly will save lives. Their use also will lower search times and costs and reduce the danger to rescue personnel.

Fruit from Afar

A decade ago, Charlotte County, Fla., was appraising its thousands of acres of citrus groves much like Florida counties had been doing for years—physically counting each and every individual tree. But over the past ten years, thanks to NASA-derived technology, instead of sending workers into the groves with counters, high-flying aircraft fitted with infrared scanners have been doing all the legwork and saving the county taxpayers $100,000 a year. Assessments that once took seven months to complete are being done in less than seven weeks.

The first flights over the Charlotte County groves using infrared photography began in 1983. Now, as a further evolution of the infrared photography system, the county—with assistance from the Kennedy Space Center—is moving away from the simple light table operation of hand-counting the individual trees from the infrared photographs, to a highly specialized computer counting and analysis system. This system will do all the counting and determine the health of the trees automatically. •

TRANSITION

Changing Jobs

Samuel W. Keller was named on July 8 as Associate Administrator for Russian Programs. The new function will give focus to the many programs involving NASA and the former Soviet Union. Keller had served as Associate Deputy Administrator for NASA since May 1989.

Bill Livingstone, who joined NASA in June as special assistant for communications, was named Associate Administrator of Public Affairs in July.

Kathryn Sullivan

On August 17, astronaut **Kathryn D. Sullivan** was detailed to the National Oceanic and Atmospheric Administration as Chief Scientist, pending Senate confirmation to make it a permanent assignment. A veteran of three space flights, Sullivan became the first spacewalking U.S. woman on her first Shuttle mission in October 1984.

Steven Hawley, associate director of the Ames Research Center, returned to Johnson Space Center on August 1 to become deputy director of flight crew operations. Prior to his Ames job, Hawley had flown on three Shuttle missions, logging 412 hours of spaceflight.

Astronaut office chief **Daniel Brandenstein** announced plans to retire from the U.S. Navy and leave NASA in October to pursue other interests. Before commanding the maiden flight of Endeavour last May, Brandenstein had flown on three previous Shuttle missions. He has logged 789 hours of spaceflight—the Shuttle record to date.

Astronaut Office Deputy Chief **Jim Buchli** announced on June 1 that he would retire from the Marine Corps and leave NASA in August to become the Manager for Station Systems Operation and Requirements with the Boeing company in Huntsville, Alabama. Buchli is a veteran of four Shuttle missions.

Astronaut **David Hilmers** will resign from NASA's astronaut corps and retire from the U.S. Marine Corps on November 1 to pursue a new career in medicine. Hilmers will attend Baylor College of Medicine in Houston. He has flown on the Shuttle four times.

Astronaut **John Creighton** retired from the U.S. Navy and NASA on July 15 to become a production test pilot and customer-support pilot for the Boeing Commercial Airplane Group in Seattle. Creighton has flown on three Shuttle missions.

Astronaut **Bruce Melnick**, the robot arm handler on last May's STS-49 mission to rescue the Intelsat satellite, retired from the U.S. Coast Guard and left NASA in July to join the Lockheed Space Operations Company at Kennedy Space Center, where he will be the director of the Shuttle processing contract improvement team. •

In Washington, rivalry between the parties is often the catalyst that makes the government work. However, the long-term success of the nation's civil space program depends on bipartisan support. And if recent voting trends are any guide, party lines in Congress are becoming even more distinct.

The Party Line

by Dr. John Lawrence,
Office of Legislative Affairs,
NASA Hq.

Among the many surprises experienced by newcomers to Washington is the intensity of political partisanship. From a distance, most of us imagine party politics to be something like the rivalry between Ford and Chevy owners—sincere but goodnatured. In actuality, it's more like the Redskins and the Giants—a hard-hitting battle for control.

Although political parties are mentioned nowhere in the Constitution, they have evolved into an intrinsic and vital part of the democratic process. Not only do party organizations identify the candidates who are traditional frontrunners for the Presidency, but party structure is woven into the fabric of Congressional procedures.

Fierce party loyalty is attributable to the thing that matters most in Washington: political power. At the Presidential level, the party in control exercises tremendous influence over top executive and judicial branch offices through the power of appointment. But these judicial, cabinet, and department-level appointments are merely the iceberg's tip. Many staff-level agency and department positions also are filled by political appointees.

In the legislative branch, the majority party also enjoys the privileges of power. Congressional committee and subcommittee memberships are dominated by the majority party, and the chairpersons are, naturally, members of that party. Accordingly, in the committees as well as on the floor of the Congress, the majority party exerts a dominating influence over the legislative agenda. In the House, for example, the Rules Committee controls the legislative schedule, the floor procedures that affect the introduction of amendments, debate and other key agenda items.

Although NASA issues generally are nonpartisan, recent votes on Space Station Freedom have shown more Republican than Democratic support. When the House voted recently on an amendment to terminate the Station during consideration of the NASA appropriations bill, Republicans voted to keep the program alive by a margin of 127-38, while Democrats opposed it by 142-110. It is possible that party loyalties were at work to some degree here. Being a Presidential initiative, Freedom might be expected to draw Republican votes, while opposition to the program by the Democratic chairman of NASA's appropriations subcommittee could sway some Democrats to vote against it. The fact is, bipartisan support is critical to the long-term success of the nation's civil space program. Many of NASA's major programs require support for periods well in excess of the political lifetime of key members of Congress—or for that matter, the President.

Intuitively, one might think that party unity is an archaic, fading tradition. Quite the reverse—"unity scores" are increasing in Congress. Party unity votes are defined as those in which the majority of members of one party vote against the majority of the other party. The following table shows the percentage of Democrats and Republicans voting with their party on the average party-unity vote. Note how the rates have increased in both parties in recent years.

Year	Democrats	Republicans
1992	88	85 °
1991	81	78
1990	81	74
1985	79	75
1980	68	70
1975	69	70
1970	57	59
1965	69	70
1960	64	69

(° votes through June 30)

Are there friendships across party lines? Certainly. But they're a lot like the friendship between Magic Johnson and Larry Bird. No matter how much they might like each other, the struggle on the court represents their livelihood, and never does one allow the other an easy advantage—exactly as in politics.

A few years ago sociologists studied prejudice by inciting brown-eyed school children against their blue-eyed classmates and then observing the resulting behavior. Of course, harmony was restored once the children realized that eye color has no relation to character. If Republicans and Democrats ever arrive at a similar conciliation, America's democratic process will be in big trouble. Because in an ironic way, it's the tension between the two parties that catalyzes the government and makes it work. •

Goddard Space Flight Center engineer David Carter uses much of his spare time to convince underprivileged students that they are this country's future.

LEAPing Ahead

by Sonja Alexander, Hq.

Back when he was in high school, David Carter remembers an engineer coming to his physics class "and more or less scaring us, telling us about all the physics and math that made an engineering career seem unreachable." Since then, he has learned through his own experience that hard work and commitment make almost anything attainable. And now he wants to spread the good word.

During the workday, Carter is the project manager for the Large Aperture Scanning Airborne Lidar (LASAL) program at NASA's Goddard Space Flight Center. But in his off hours he serves as a mentor for the Learning Enhancement and Achievement Program (LEAP), which is designed to tutor disadvantaged minority students who are performing below their potential. Carter works with children at Goddard Middle School, Goddard's "adopted" school in the Maryland suburbs of Washington, D.C.

A 28-year-old graduate of the University of Maryland, he also has a masters in Engineering Management from George Washington University. Like many students, Carter says he entered college undecided about a career choice. At first he considered becoming a lawyer. Then, after taking a mechanical engineering course as a sophomore, he decided to switch gears.

Carter started working at Goddard while still an undergraduate at Maryland, and had his first experience with volunteer service at about the same time. As he traveled throughout the United States on NASA business, he would speak to students and encourage them to enter the engineering field. After graduating from Maryland, he continued to work at Goddard and became more involved with underprivileged minority children attending area high schools.

Besides serving as a mentor in the "LEAP" program, Carter works with students through the Black History Club at Goddard and the Summer High School Apprenticeship Research Program (SHARP). He also takes time to participate in career fairs at elementary schools, middle schools and high schools throughout the Washington, D.C., area. By working closely with students, Carter is able to encourage their self-esteem and help prepare them for technical careers.

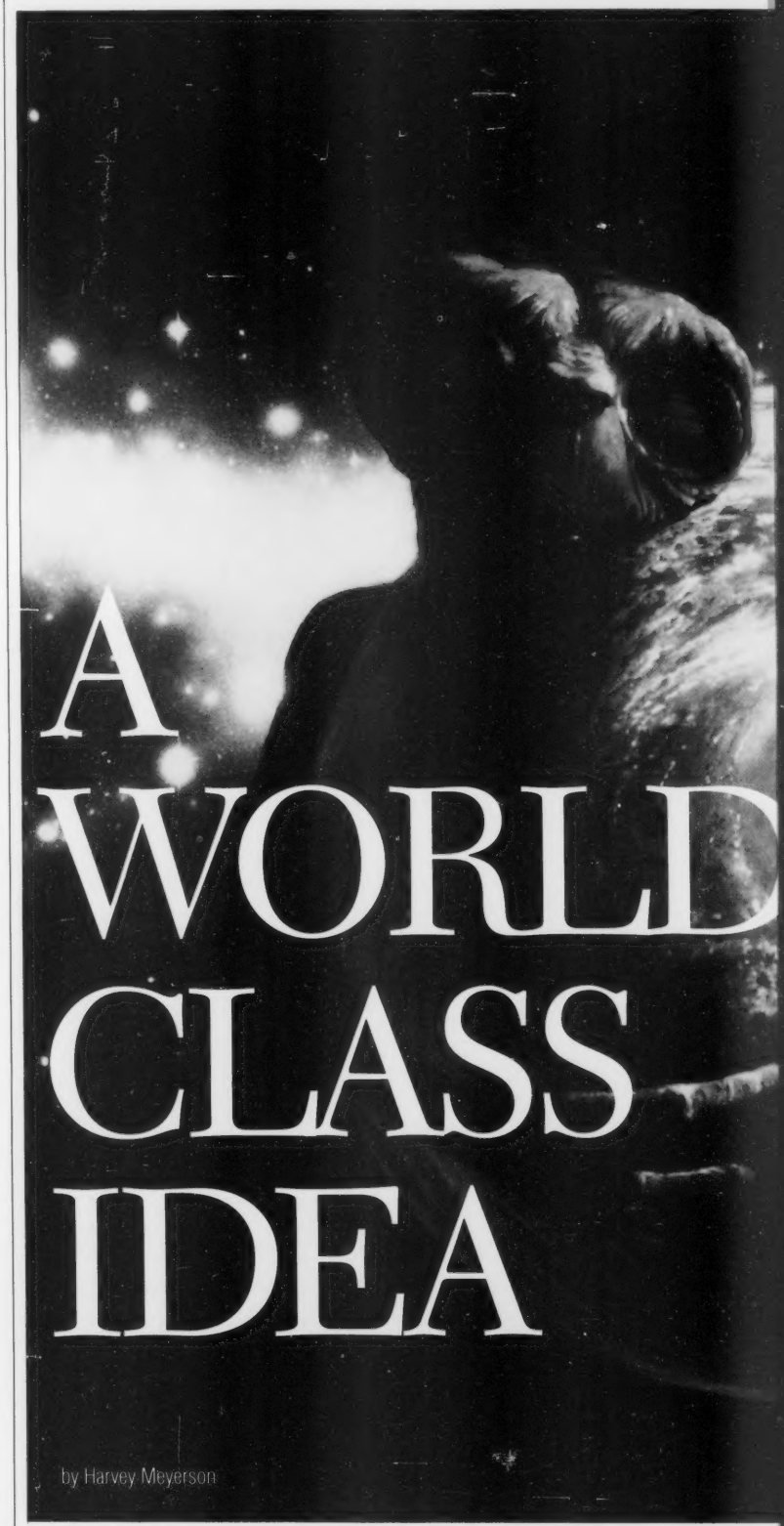
Though Carter's volunteer efforts have earned him recognition and awards, they're not the main reason for all his hours of volunteering. He talks instead about "the opportunity to help inform students and to be a role model."

Many students, especially if they're minorities, need encouragement to further their education and advance into fields like engineering, says Carter. That's why he tells organizers of volunteer groups such as the Black History Program, "anytime they need someone to speak to the students or faculty, just give me a call."

Even though he's recently married and has a demanding career, Carter says he'll always find the hours to work as a volunteer, whether it's speaking to an auditorium full of grade schoolers or sitting down one-on-one to help convince a college student that they really can make an important contribution to the nation's future.

"I make the time to give back to the community," he says. "Not everyone is fortunate enough to have the support of family and friends. I was." •

A WORLD CLASS IDEA



by Harvey Meyerson

A student opera in Minneapolis, a play in London, a 45-minute jazz piece performed at the Smithsonian.

A Buddhist ceremony in Nara, Japan, an art exhibit in New York, a rock concert in Los Angeles.

A public television series, a float in the Rose Parade, a mind-boggling "sculpture" one billion kilometers high, created by beams from laser ranging stations in Austria, Egypt, Germany, Israel, Russia and Spain.

What do they have in common? They're all part of the 1992 International Space Year (ISY)—the first year-long, worldwide celebration of humanity's future in the space age.

Perhaps the most distinctive aspect of this uniquely successful global experiment is the idea behind it. From the time the ISY was proposed in 1985 by the late U.S. Senator Spark Matsunaga of Hawaii, the concept was to address space as both a place and an age—a distant place to learn about and explore, and a planet-wide age that compares to the momentous time when life first emerged from the sea to conquer the land. The "ISY idea" linked the space *place* and the space *age* by assigning first priority to their shared, space-inspired, global perspective.

New global age of information? New global age of ecology? New global age of communications? In the context of the ISY idea, they were all expressions of a more comprehensive Age of Space. After all, the "global village" of communications and information was made possible by the use of Earth-orbiting satellites. Similarly, the inspirational icon of the world environmental movement was a photograph of Earth taken by Apollo astronauts. Throughout society, humanity's advance into space was creating new global paradigms for thought and action on Earth.

The ISY idea's openness to all public constituencies was reflected in its organizational framework. Unlike other celebratory "years," the ISY was notable for its deliber-

Movie director Steven Spielberg offered E.T. as an ambassador for the ISY's global ideals and objectives.

The International Space Year was born from a simple yet profound premise: The global space age has already begun.

ate absence of centralized management. There was no single headquarters for ISY public activities, no top-heavy organizational chart. Our goal was not to organize the space age—who organized the Renaissance? That would be pretentious and impossible anyway. Instead, our goal was to tap into the energy of this new age, and in the process show how much its manifold expressions owed to space research and exploration.

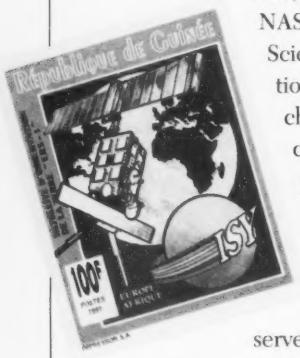
To that end, six years ago, with NASA's support, we started the U.S. International Space Year Association to promote the ISY idea with the public in a climate of maximum openness. Instead of any "official" sanctioning or licensing procedure as was done for the Columbus Quincentenary, we placed the ISY logo in the public domain. The logo served as a unifying symbol for an unfolding idea that was "owned" by no one and open to everyone. We called this decentralized approach, "management by inspiration." One model was the Fourth of July. Nobody coordinates the thousands of Fourth of July activities celebrated nationwide every year. They spring up spontaneously, in the best American tradition, inspired by information about what others are doing.

After placing a few articles in general publications to start the ball rolling, we issued a newsletter and news releases reporting on an initial handful of planned ISY activities, hoping they would provoke even more ideas. Public television station WQED of Pittsburgh immediately responded with a very good one. In association with the National Academy of Sciences, and with seed money and other key support from NASA, WQED began work on a television series for ISY 1992 with the perfect title of *Space Age*. At about the same time, an official at the American Institute of Aeronautics and Astronautics thought of celebrating the ISY idea with a "World Space Congress," and that immense project was set in motion.

We also organized many planning conferences and meetings. The Pacific ISY

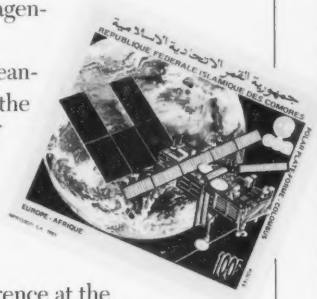
Conference, held in Hawaii in August 1987 under Senator Matsunaga's auspices, launched the ISY internationally following its strong endorsement by the U.S. Congress, NASA and President Reagan. Lennard Fisk, chief of NASA's Office of Space Science and Applications, served as co-chairman of the conference science program, and Don Fuqua, head of the Aerospace Industries Association of America, served as industry program co-chairman, with Japanese co-chairmen and strong worldwide participation. Among other projects, the immensely successful IMAX film *Blue Planet* was conceived at the Pacific conference by officials of IMAX Systems and the National Air and Space Museum.

Wind-powered replicas of Columbus' exploration ships, the Nina, the Pinta, and the Santa Maria, sail past the Space Shuttle Endeavour as it awaits lift-off on its maiden voyage in May.



At that same conference, the attendees strongly agreed that "Mission to Planet Earth" would be a central theme for space agencies and international research organizations during the ISY. Earth observation allowed wide participation from non-launching as well as launching nations. It also offered opportunities for global coordination of existing programs and resources, which was crucial considering budgetary constraints and the relatively short lead time for ISY 1992.

The following spring, NASA hosted an ISY Mission to Planet Earth conference in New Hampshire that established the Space Agency Forum on ISY (SAFISY) and formally adopted the "Mission to Planet Earth" theme. SAFISY was a decisive legitimizing step for the ISY, and the conference was a great tribute to NASA leadership in attracting senior officials from 18 national space agencies.



Meanwhile, the idea of increased public involvement was taking hold. In spring 1989, we organized a conference at the National Academy of Sciences for large national organizations not involved in space. The conference included panels on the global marketplace, global environment, global frontiers and global information, with speakers ranging from the head of the National Academy of Engineering to the head of Chicago's Museum of Science and Industry. Officials from organizations as diverse as Turner Broadcasting and the American Association of Retired Persons attended, clearly demonstrating that the space age is of immediate relevance to everyone.

One outgrowth of that conference was a briefing at NASA Headquarters for the entire Board of Directors of the 600,000 member Sierra Club, most of whom admittedly knew very little about space, but felt an affinity for space exploration nonetheless. Sierra Club members are more than just environmental protectionists. They're also backpackers, trailblazers and explorers, and the Mission to Planet Earth was an ideal way to interest them in the connection between Earth and space.

A culminating event was the ISY Global Change Education Conference at the National Academy of Sciences on May 13, 1992, organized by the US ISY Association and hosted by NASA. The meeting was

attended by representatives of 92 national organizations that reach virtually the whole American population, from the Boy Scouts to the Junior League. At that conference, we premiered a poster depicting "E.T." hugging the Earth, an image that was at once cosmic and intimately caring—space speaking to Earth, teaching us to love our planet, inviting us to explore the cosmos from whence the caring message came. The response was tremendous.

There are now more ISY activities than we can count—some already underway, others still to take place—involving people and constituencies whose participation we couldn't have imagined five years ago. When we stopped counting last year, the nongovernment investment in ISY activities exceeded $50 million in the United States alone. Parallel ISY associations have been established in Europe and Japan, supported by the European Space Agency and the two Japanese space agencies, NASDA and ISAS. Similar public-oriented initiatives also are underway in nations large and small—from Brazil to Sri Lanka, China to Morocco. In many of those regions, the ISY constitutes the first large-scale space-related public endeavor.

All in all, it's been a most successful beginning. But an age isn't born in a year,

New global age of information? New global age of ecology? New global age of communications? In the context of the ISY idea, they were all expressions of a more comprehensive Age of Space.

nor can it be raised into consciousness in a year. As 1992 draws to a close, the challenge is to keep the ISY idea active and expanding toward its fullest realization.

The ISY's global perspective is much more than just a coordination of activities. Equally important for the long-term, broad-based support that space exploration requires is the transgenerational outlook a global perspective should bring. Ages unfold over periods of hundreds of years. The Renaissance wasn't even named until many generations after it was experienced. What is unique about the space age is our awareness of its unfolding. Merely adjusting to that new framework requires an immense effort that can only be led by the space program.

When NASA Administrator Daniel Goldin calls for a space program that looks not only 50 years ahead but also 500 years, he amplifies and enriches the ISY idea. He begins a process upon which the ultimate success of space exploration—and the ultimate future of the people of planet Earth—depends. We wish him and his colleagues well in fulfilling the awesome responsibility, shared by no other agency of government, of serving as the spokespeople for a new global era—the Age of Space. •

Harvey Meyerson is the President of the U.S. ISY organization.

An ISY Sampler

Here are just a few of the meetings, programs and products planned in association with International Space Year:

Science

World Space Congress—This ISY-dedicated meeting, which convened August 28 to September 5 in Washington, D.C., was sponsored by the Committee on Space Research (COSPAR) and the International Astronautical Federation (IAF). It was the largest gathering of space scientists, engineers and program managers ever held.

GEOSCOPE Global Change Encyclopedia—Members of the Space Agency Forum on ISY (SAFISY), led by the Canadian Space Agency, have produced the first computerized interactive encyclopedia of planet Earth for distribution to schools and libraries worldwide.

World Forest Watch—In this project led by Brazil and the European Community, SAFISY members have pooled data on deforestation, begun a worldwide inventory of forests and laid the foundations for an ongoing satellite-based forest monitoring system.

Greenhouse Effect Detection Experiment—NASA is leading this SAFISY effort to compile data on global climate change and place them onto CD-ROM discs in an attempt to better assess how global warming can be detected.

World Astronomy Days—On several designated days during 1992, many of the world's observatories and space telescopes are watching the same celestial objects simultaneously in different regions of the spectrum under this SAFISY project led by NASA and the European Space Agency.

Public Education

"Space Age"—This six-part public television series tracing the history and impact of the space age, produced jointly by WQED/Pittsburgh and NHK/Japan, is scheduled to premiere in the United States in October.

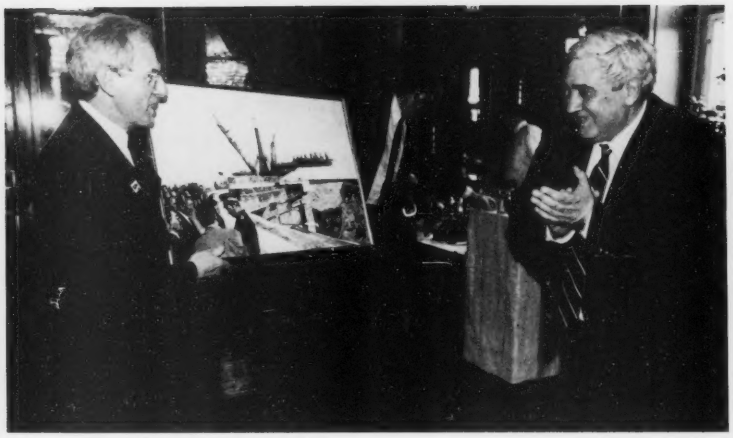
Young Astronaut Activities—The Young Astronaut Council has distributed an ISY "Exploration and Discovery" curriculum to 100,000 schools and has developed related activities ranging from an ISY poster contest to special "Happy Meals" at McDonald's restaurants.

"Marsville—The Cosmic Village"—The Challenger Center for Space Science Education is conducting this nationwide program of simulation exercises whereby students in grades 5-8 design their own Martian habitat.

"Visions of Exploration: Past, Present, Future"— This ISY curriculum for grades 3-8, created by the newspaper, *USA TODAY*, focuses on the history of exploration and how students themselves can be explorers.

Student Payload Rocket Launchings—The Rocket Research Institute and its counterparts in other countries are helping thousands of grade school and college students launch their own experiments onboard rockets during ISY.

"Star Trek: Federation Science"—This traveling ISY exhibit developed by the Oregon Museum of Science and Industry uses "Star Trek" themes to explain science concepts to museum visitors.



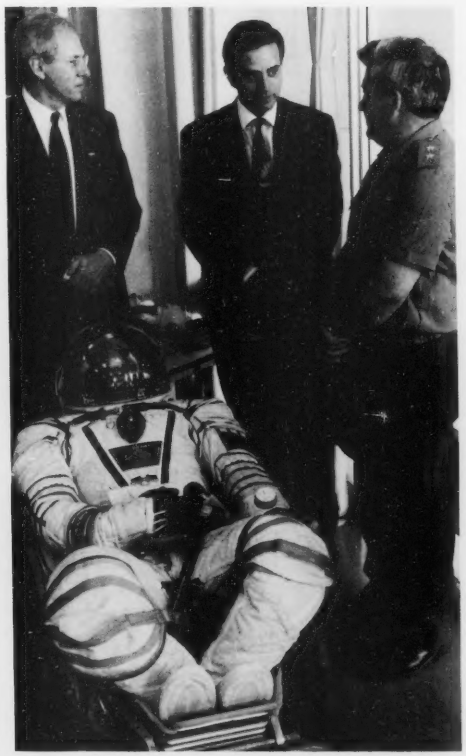
As a result of the first government endorsed U.S.-Russian space artists' exchange, Goldin presents the first product of the exchange—a painting entitled, "Last Launch of the Soviet Union," by NASA art program artist John Solie—to Director General of the Russian Space Agency, Yuri Koptev.

▶
At a reception ceremony bringing to a close the week-long Russian trip, Goldin and Koptev sign a summary of the results of the visit.

An ISY First: A Russian

At the NPO Energia aerospace firm in Kaliningrad, Goldin sits in the Soyuz-TM spacecraft—the potential emergency interim spacecraft for Space Station Freedom.

▶
General Pyotr Klimuk, (far right) Commandant of the Gagarin Cosmonaut Training Center talks to Goldin with an EVA spacesuit in foreground.



▲ *Goldin, outside of Zagorsk Monastery in Moscow, receives a pin from a Russian woman and in return, presents her with a NASA meatball pin and a Shuttle mission patch. (See details in the Administrator's column, inside front cover)*

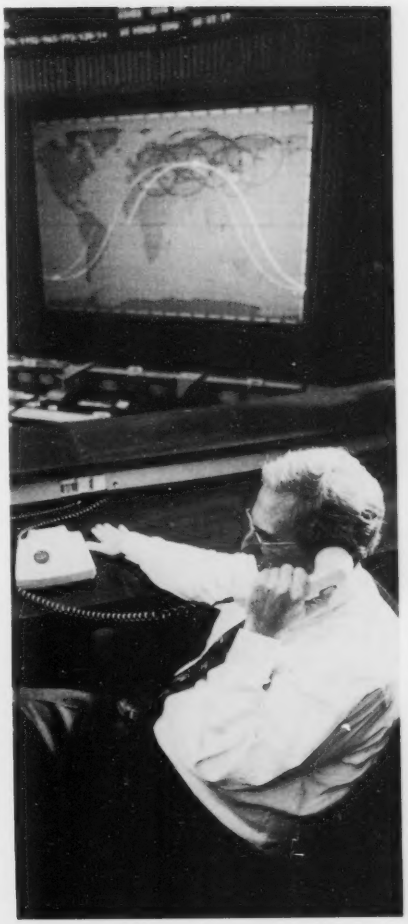
Odyssey

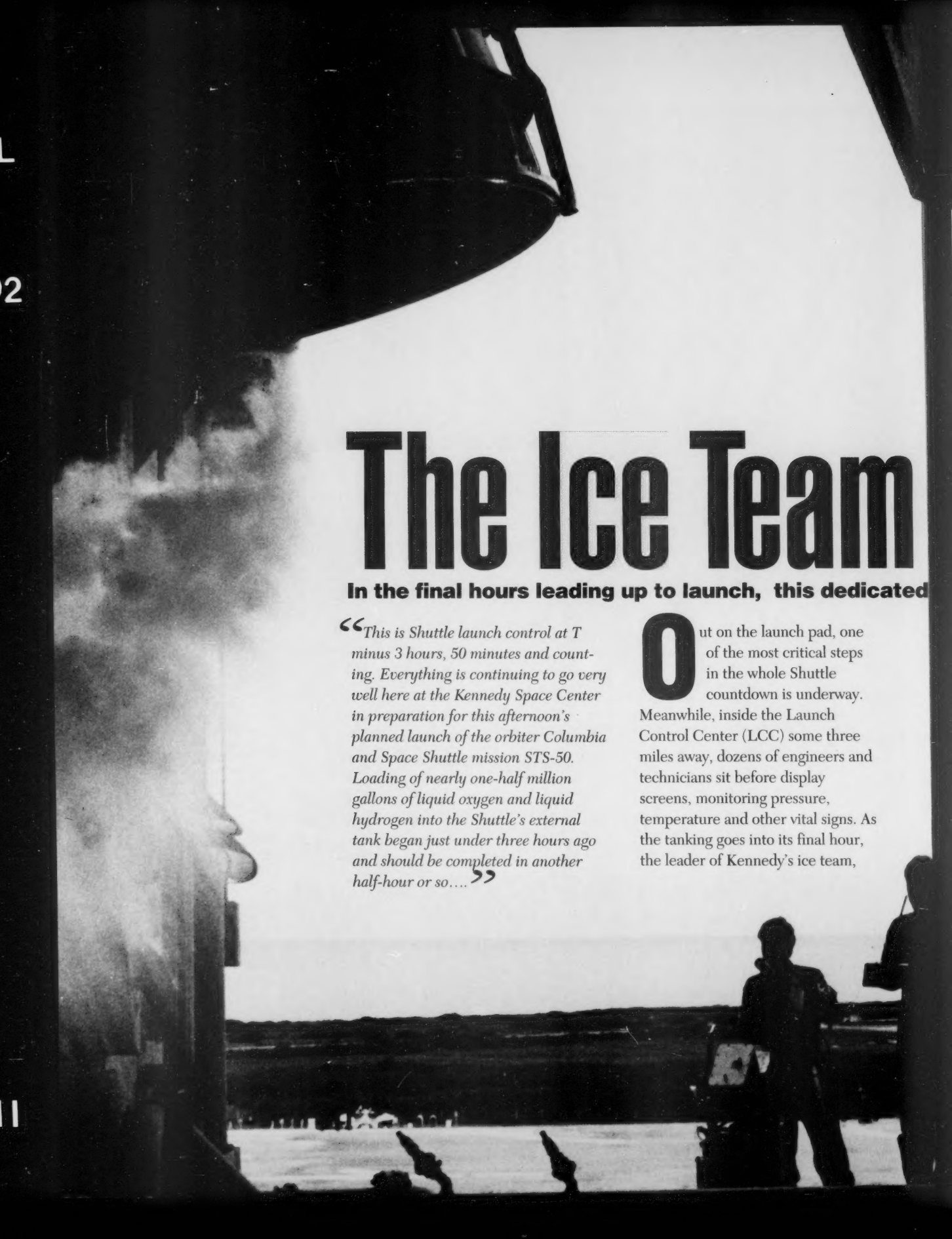
In July, NASA Administrator Dan Goldin, together with National Space Council executive secretary Brian Dailey, led a team of U.S. space experts to Russia to bring to fruition an agreement signed in Washington in June by Presidents Bush and Yeltsin. That agreement, to increase cooperation in space between our two countries, took a major step forward during this trip. Goldin said significant progress had been made in developing a plan to carry out a wide range of projects, including expansion of cooperation in life sciences and global change research, the exchange of an American astronaut and Russian cosmonaut, and a Space Shuttle rendezvous and docking with the Russian Mir space station.

These photographs, taken by NASA Headquarters photographer Bill Ingalls, capture the flavor of the trip.

▶ *At the Russian Space Agency's spaceflight control center in Kaliningrad, Goldin talks to cosmonauts on the Mir space station.*

Goldin toasts his host, NPO Energia General Director and General Designer, Yuri Semenov, (pictured at Goldin's right) at a luncheon in Goldin's honor. At far left of photo is Yuri Koptev and beside him, the executive secretary of the National Space Council, Brian Dailey. ▼





The Ice Team

In the final hours leading up to launch, this dedicated

"This is Shuttle launch control at T minus 3 hours, 50 minutes and counting. Everything is continuing to go very well here at the Kennedy Space Center in preparation for this afternoon's planned launch of the orbiter Columbia and Space Shuttle mission STS-50. Loading of nearly one-half million gallons of liquid oxygen and liquid hydrogen into the Shuttle's external tank began just under three hours ago and should be completed in another half-hour or so...."

Out on the launch pad, one of the most critical steps in the whole Shuttle countdown is underway. Meanwhile, inside the Launch Control Center (LCC) some three miles away, dozens of engineers and technicians sit before display screens, monitoring pressure, temperature and other vital signs. As the tanking goes into its final hour, the leader of Kennedy's ice team,

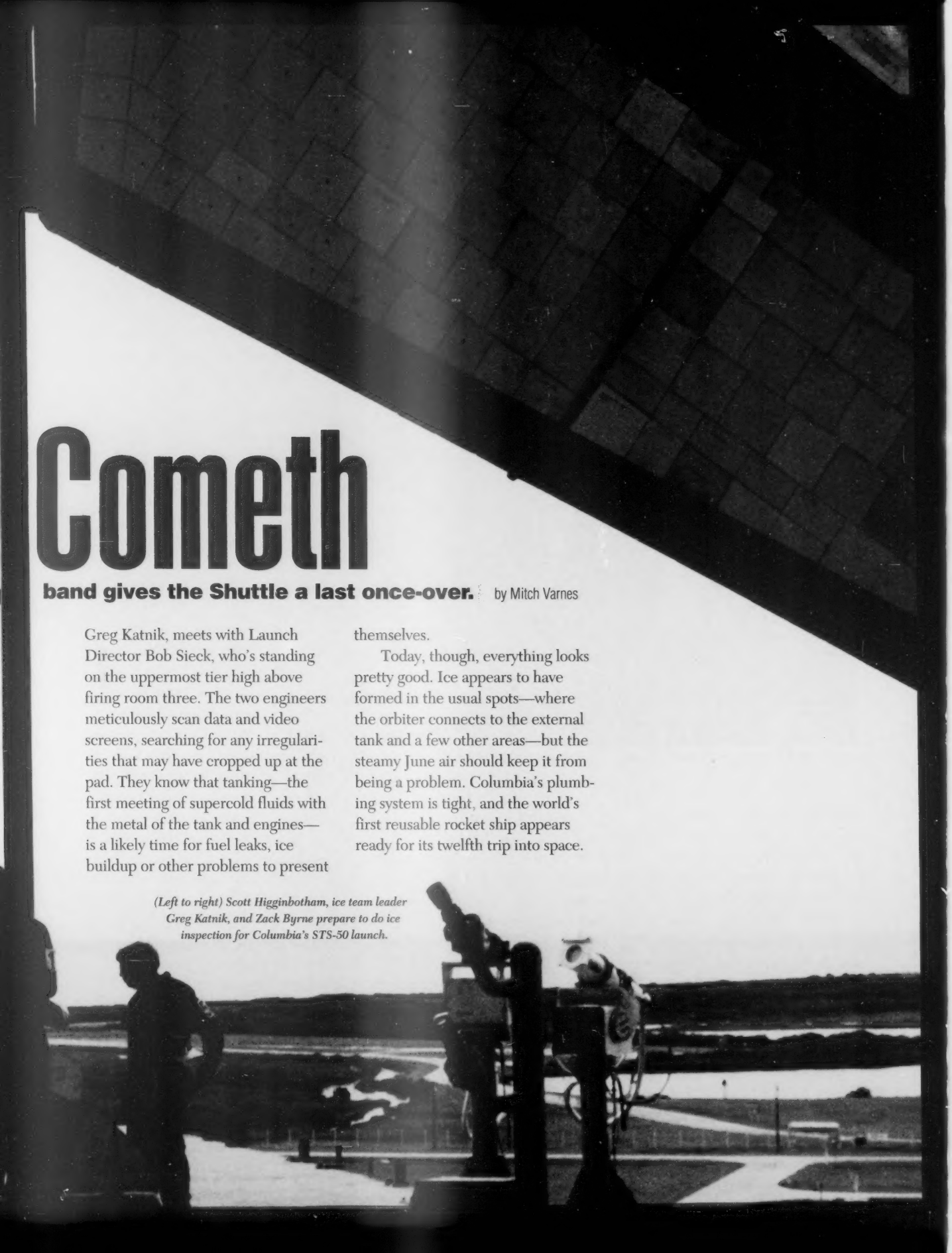
Cometh

band gives the Shuttle a last once-over.

by Mitch Varnes

Greg Katnik, meets with Launch Director Bob Sieck, who's standing on the uppermost tier high above firing room three. The two engineers meticulously scan data and video screens, searching for any irregularities that may have cropped up at the pad. They know that tanking—the first meeting of supercold fluids with the metal of the tank and engines—is a likely time for fuel leaks, ice buildup or other problems to present themselves.

Today, though, everything looks pretty good. Ice appears to have formed in the usual spots—where the orbiter connects to the external tank and a few other areas—but the steamy June air should keep it from being a problem. Columbia's plumbing system is tight, and the world's first reusable rocket ship appears ready for its twelfth trip into space.



(Left to right) Scott Higginbotham, ice team leader Greg Katnik, and Zack Byrne prepare to do ice inspection for Columbia's STS-50 launch.

Ice team leader Greg Katnik checks out the awesome, fully fueled Space Shuttle.

"T minus 3 hours, 20 minutes and counting....Loading of liquid hydrogen into the external tank was completed a few minutes ago, and topping of the liquid oxygen segment should be completed in about ten minutes. The ice inspection team is now gathered together, undergoing a final briefing before heading to the pad for inspections...."

In a modular facility across from the LCC, Katnik and seven associates are tediously reviewing every available scrap of data about the vehicle that soon will be launched into space. The biggest concern is the weather. Recent rain showers have deluged the pad, and Katnik warns everyone to watch out for slippery surfaces when they get on the launch tower. He also asks them to examine Columbia closely to make sure the tiles are still bound properly and that nothing looks unusual.

With no further questions from the group, the members of the ice team don bright orange, flame-retardant jumpsuits and gather the tools of their trade: binoculars, checklists, radios for communicating with the LCC, a portable infrared detector with video screens and recorders, a handheld infrared thermometer, and an assortment of cameras and lenses. Each also carries an Emergency Life Support Apparatus (ELSA), which holds ten minutes' worth of breathing air. Once everything is in order, the group boards a van and drives to a security roadblock three miles from the launch pad.

"T minus 3 hours and holding....We're now in a planned two-hour-long built-in hold that will allow the launch team to catch up on any remaining work. NASA Test Director Al Sofge has given the ice team and astronaut closeout crew an okay to proceed to the launch pad...."

Now begins the lonely trek to the pad. It's one of the only opportunities the 34-year-old Katnik has to reflect on the important role his team plays in clearing a Shuttle for flight. Their job is one of the few in the whole countdown that involves personal judgment. Most other steps are clear-cut—either the system is working or it isn't. Ice inspection is more a matter of how much. The low temperatures of liquid hydrogen (-423° F) and liquid oxygen (-297° F) make some ice formation on the tank a fact of life. The team's job is to make sure the buildup isn't excessive and that ice doesn't form in the wrong places. During the violent jarring of a launch, even a small sliver of ice could cause substantial damage if it were to hit an orbiter's tiles, wings or windows.

An anxious feeling almost always descends on Katnik as he approaches

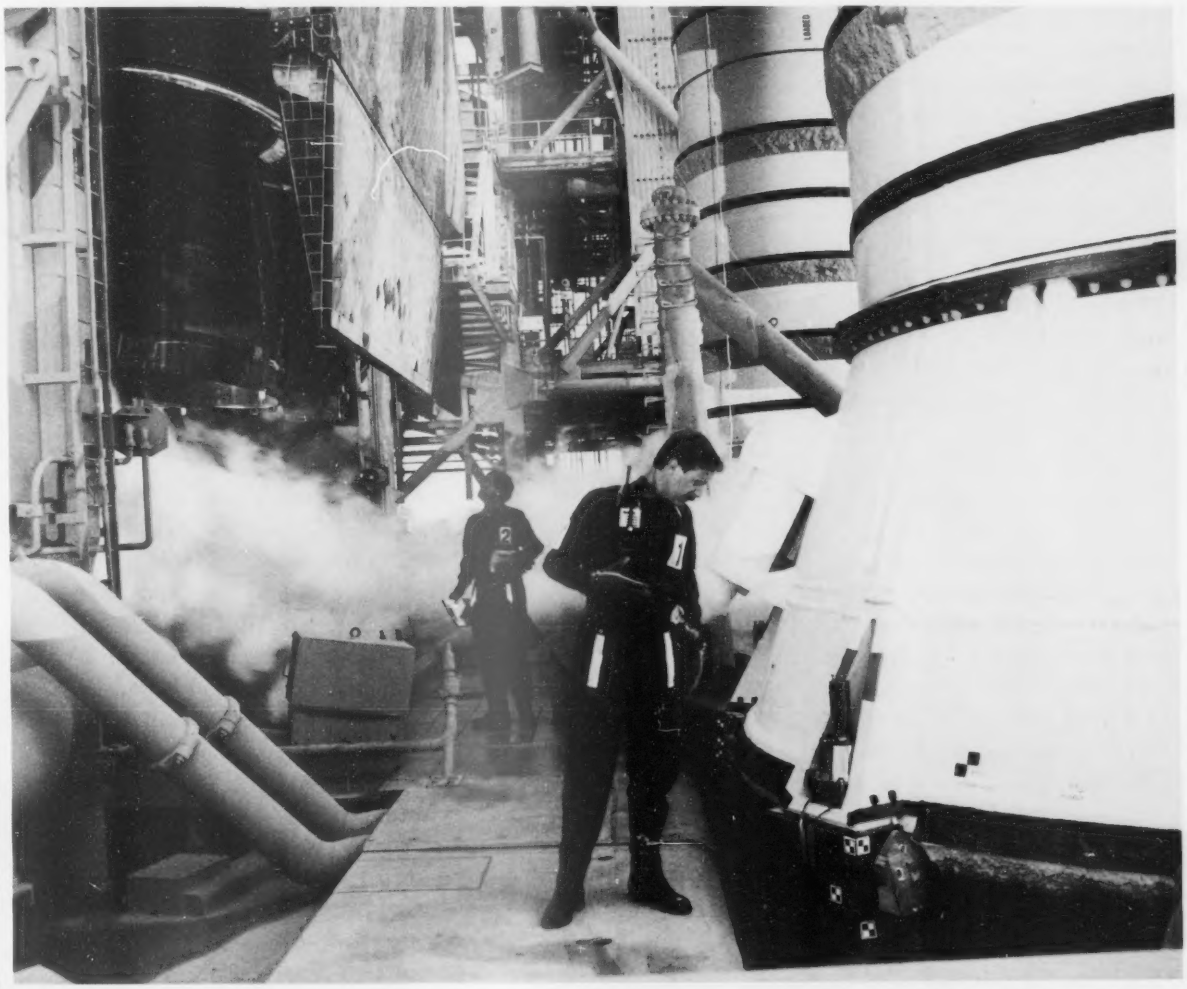
the fully fueled rocket. Watching TV monitors or looking out the windows of the LCC, Columbia could be a hundred miles away. But here, on the drive out to the pad, the enormity and real danger of his job hit home every time.

Pulling the van up the ramp and onto the pad surface, Katnik rolls the window down and sniffs the air. The ground is wet from the rain, but there are no strange odors. Now he listens for odd noises. The mammoth Shuttle sounds every bit as alive as the first time he made an ice inspection some three dozen launches ago. The rhythmic purging of gases is loud and incessant. Katnik compares it to the sound of a runner hyperventilating, prepping for a sprint.

After unloading their gear and double-checking that everything works properly, the ice team walks to the steel structure. Katnik pushes a button and they all step into the same elevator Columbia's astronauts will use in just a couple of hours. At the Mobile Launcher Platform (MLP) level the door slides open, revealing the full Shuttle stack as few people ever get to see it.

The team is tight, and there are no questions about who's supposed to do what next. In only two hours they have to inspect the tank, orbiter, solid rocket boosters and launch tower—all the while hindered by the near-deafening roar of venting gases.

Pairing off according to the buddy system, the team scatters around the launch platform, which is roughly the size of the infield at a major league ballpark. Engineer Scott Higginbotham pulls a chest-high cart holding the portable Shuttle Thermal Imager (STI). With



Greg Katnik (foreground) and Bob Speece know exactly who does what next.

external tank expert Steve Copsey, he begins pointing the STI at the outside of the tank, probing for anomalies or excessive ice build-ups. If there's ice on this vast expanse they call "acreage," the STI will find it. It's a marvelous tool that video records everything it sees. And should a hydrogen fire occur, the STI would be able to detect the near-invisible flames.

Higginbotham, a veteran of 13 pre-launch ice inspections, is confident and upbeat as he sidesteps a small puddle. The warm weather has helped prevent ice from developing, and the rain has washed away any extra ice that might have formed. On a cold January or February day, he'd really be worried about rain on the acreage. On this muggy June morning, it's not a concern.

The rest of the ice team's observations are every bit as favorable as they roam the launch platform. Randy Seale and Armando Oliu have been circling the tank, pointing a handheld infrared thermometer up and down the vehicle. The temperatures are fine—well within limits.

Peering up at the 4.5 million-pound Shuttle stack through his binoculars, Katnik eyes a 10 inch-wide crack in the foam covering the outside of the external tank, right near one of the struts that connects the tank to Columbia. Katnik makes notes and takes lots of photos and thermal images, but even before seeing the crack up close, he knows it's probably not a showstopper. He's seen breaks in the foam before. In fact, he saw a similar fault only a month earlier, on the day Endeavour made its first space flight.

Aware of the short time remaining, Katnik gathers his team and ushers them to the elevator for an

Left to right are team members Greg Katnik, Scott Higginbotham, and Randy Seale.

The ice team's job is one of the few in the whole Shuttle countdown that involves personal judgment. Most other steps are clear-cut—either the system is working or it isn't....

even closer look at the Shuttle. Each of four stops brings them to a new, higher level of the launch tower—each one a potential trouble spot for ice formation. During past countdowns the team's findings have led to management discussions about safety issues, but no launch has ever been scrubbed on account of ice. Still....

At the 135-foot level, the team takes a close look at the umbilicals connecting the external tank to the orbiter. The stop at 195 feet allows good visibility of the orbiter access arm and the upper hydrogen tank. At the 215-foot level, they can see if any unusual ice has formed around the intertank area or any of the forward orbiter and solid rocket booster attach points. And at the last, highest stop—255 feet—the team can easily inspect the upper portion of the liquid oxygen tank and the gaseous oxygen vent hood, or "beanie-cap," that surrounds the tip of the tank.

Riding down from the 255-foot level, Katnik and his team are pleased with what they've seen. Columbia's tiles are all well-bonded and in good shape. The tank is frost-free, the ice only appears where it's supposed to appear, and none of it exceeds the 1/16th-inch thickness permitted under launch commit guidelines. Best of all, that crack in the foam turned out to be exactly what the team suspected: a crack in the foam, and not a structural defect or something more serious. Keying his radio, Katnik calls the test director in the firing room and reports that all is well. But just to reassure himself and the rest of the team, he punches the button for the launch platform level and one last look.

"T minus 3 hours and holding. We are now nearing the completion of this planned two-hour built-in hold, and all continues to proceed on schedule. The seven STS-50 astronauts are outfitted in their flight suits and will soon be leaving their crew quarters to begin the drive out to the Shuttle Columbia on launch pad 39-A...."

It's been over 90 minutes since Katnik and the team left the zero-level of the platform to climb the tower, but they always stop there for a final check before going back to the safe harbor of the LCC.

Columbia's cryogenic fuels have had plenty of time to cold-soak into the tank and associated lines. If there's going to be an icing problem, chances are it would show itself by now. Sidestepping the stack, the team members once again scrutinize the vehicle. No ice or vehicle problems appear, and they have a consensus: Columbia's ready to fly.

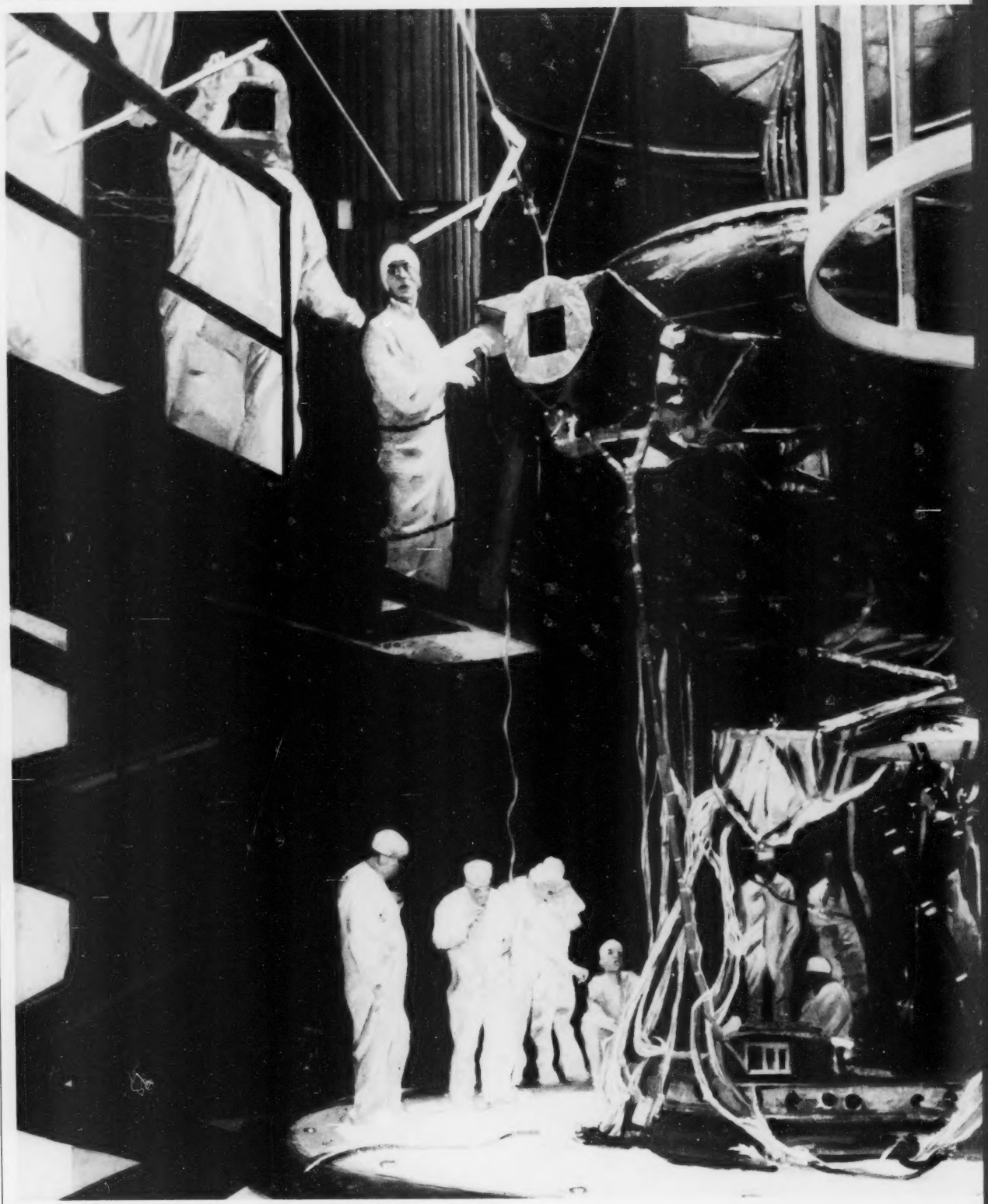
Loading the equipment back into the van, the ice team triple-checks to make sure nothing has been left behind. Forgetting to bring the right gear for the inspection would be bad enough, but leaving something behind on the pad—where it might get churned up in the fire and smoke of the launch and hit the vehicle—could be much worse.

Katnik eases the van down the ramp and out of the pad's security gate before radioing the good words to the test director. That duty done, he notices a pair of headlights coming toward his vehicle. Waving as the astronaut van approaches and passes, the team sits back and relaxes. Patches of blue begin to burst through the near-cloud-covered sky. Maybe we'll actually launch today, Katnik thinks. He knows his team has done their part. There's a clean vehicle out on the pad. The rest is up to Mother Nature. •

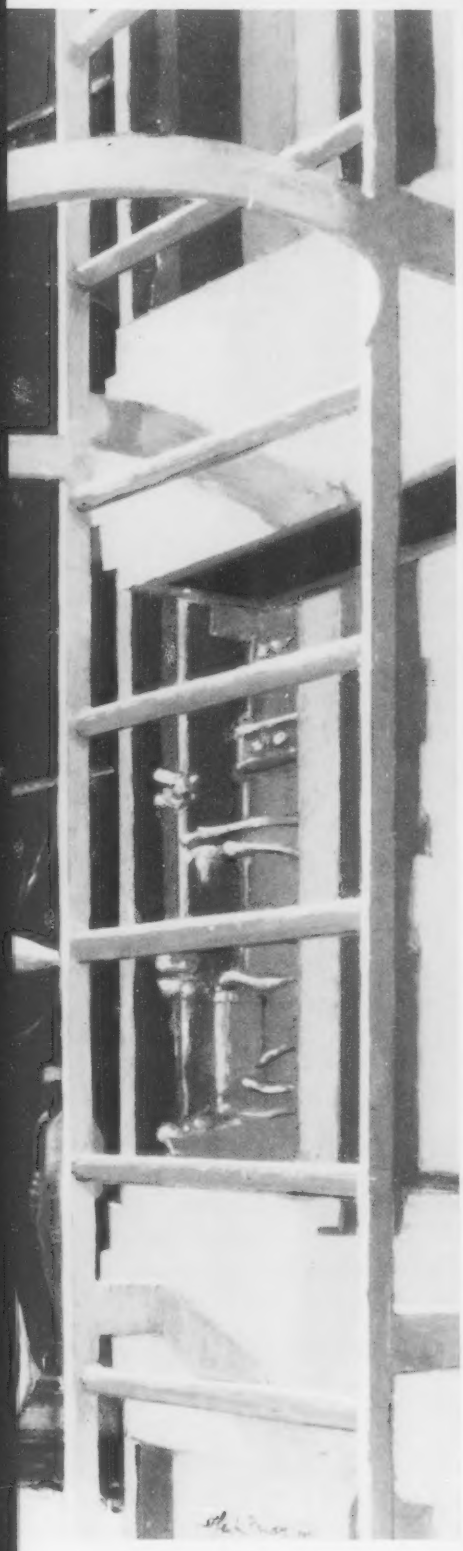
Editor's Note: Columbia launched from Kennedy Space Center on June 25, just a few hours after the ice team completed its inspection. Mother Nature did play a part, however; the launch was delayed five minutes due to cloud cover.

Mitch Varnes is a public affairs officer at the Kennedy Space Center. He wrote about wildlife at KSC in our Spring 1992 issue.

Pictured far left is ice team member Ruth Lovelace; other team members pictured left to right in front row: Zack Byrne, Steve Copsey, and Scott Higginbotham. Back row left to right: Greg Katnik, Bob Speece, and Randy Seale.



NASA Art Program artist Henk Pander painted "Galileo Test," depicting the Galileo spacecraft undergoing the Solar Vacuum Test before it was launched on STS-41.

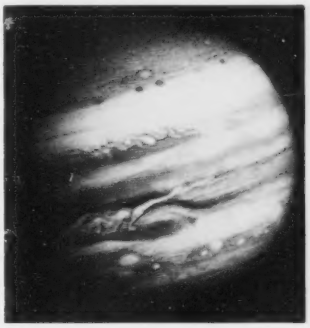


Jupiter, The Hard Way

The Galileo spacecraft team has weathered problems, delays, changes and stuck antennas, and still they've managed to put together a top-flight planetary mission.

By Charles Redmond

At 10:10 am EST on December 8, the most sophisticated planetary explorer ever built will swoop to within 200 miles of the South Atlantic Ocean, at a point approximately midway between Capetown, South Africa, and Buenos Aires, Argentina. The spacecraft, named Galileo after the great scientist of the Italian Renaissance, will be moving at a relative speed of about 20,000 miles per hour as it passes the planet of its origin.



It won't be the first "stop" on Galileo's long, winding journey, and it's far from the last.

The whole purpose of the Earth flyby, in fact, is to give the spacecraft the last boost of energy it needs to reach its ultimate destination, Jupiter, in 1995. Since it was launched from Space Shuttle Atlantis in October 1989, Galileo has robbed energy from Venus and Earth in a series of gravity assists that already has taken it the equivalent of four and a half Earth orbits around the Sun. This looping path,

called the VEEGA (Venus-Earth-Earth Gravity Assist) trajectory, was necessary because the Shuttle-Inertial Upper Stage (IUS) combination didn't have enough energy to boost Galileo directly to Jupiter.

When it flies past our planet for the second time this December, Galileo will be observing the Earth and Moon just as it did during the first flyby in 1990. After that, it speeds off for an encounter with the asteroid Ida next August.

Then, in July 1995, Galileo's probe will split off from the larger orbiter to pursue its own separate path to Jupiter. Finally, in December 1995, the probe will plunge into the Jovian atmosphere while the orbiter begins a long-term science mission that includes multiple close encounters with the large moons Io, Europa, Ganymede and Callisto, observation of the great weather systems boiling and roiling within the myriad jet streams of Jupiter's atmosphere, and investigation of the planet's huge magnetosphere.

In the three years since it left Earth, Galileo has performed well say the engineers and scientists at the Jet Propulsion Laboratory who are responsible for the mission. Jim Erickson, deputy manager of the engineering office, is one of hundreds of individuals working on the Galileo project at JPL. Like the rest of the team, he's proud of what already has been accomplished. "We know we can fly encounters," he says, referring to Galileo's past meetings with Venus, Earth and the asteroid Gaspra. "We know we can handle the instruments and all their interactions. We're really confident about that."

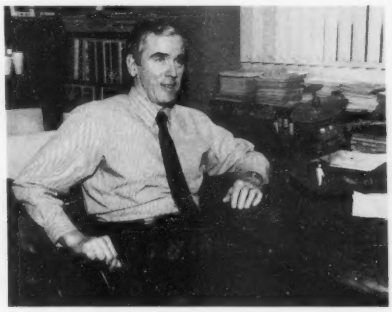
Dick Spehalski: "I viewed Galileo as a hell of a big job. It didn't deter me from wanting to do it, but we were looking at all these new, complex things. And they all had to come together at the same time."

What Erickson and his colleagues are equally confident about is their ability to fulfill Galileo's primary mission: providing more data than either of the two Voyager spacecraft did about the Solar System's biggest planet.

The Galileo project came into being in October 1977, at an auspicious time for U.S. planetary exploration. NASA was still operating the Viking orbiters and landers that had arrived at Mars more than a year earlier, and two Voyager spacecraft had just been launched to Jupiter, Saturn and points beyond. In the midst of all this activity, NASA recommended in January 1977—and Congress approved in mid-year—the start of the "Jupiter Orbiter Probe" project. The project was to be managed by JPL, which already was responsible for Voyager and the Viking orbiters.

Voyager project manager John Casani was picked to manage Galileo; he was to stay with the project until 1988. Casani gathered about him some of the best talent JPL had to offer. Bill O'Neil, Galileo project manager since early 1990, says, "The Galileo team was first-rate. They clearly went for the best, and they got it."

The people selected to design the spacecraft had worked on quite a number of planetary exploration vehicles already, so they were well seasoned. But by the time their job was through, Galileo would undergo so many changes in plan that deputy mission director Matt Landano says he stopped counting. "We were changing our launch vehicles almost every year, and every time we changed our launcher we had to change parts of the spacecraft configuration and the mission design."



Bill O'Neil: "The Galileo team was first-rate. They clearly went for the best, and they got it."

Dick Spehalski, Galileo project manager from 1988 to 1990 and now manager of the Cassini Saturn mission, notes the challenge the team faced nearly 15 years ago: "At the time we started Galileo, we were plowing a new path. This would be the first planetary program on the Shuttle....the first RTGs [radioisotope thermoelec-

tric generators] on the Shuttle, the first major international cooperative effort on a planetary spacecraft, the first use of the Inertial Upper Stage for a planetary mission. There were a lot of firsts."

Spehalski recalls his thoughts at the time: "I viewed it as a hell of a big job. It didn't deter me from wanting to do it, but we were looking at all these new, complex things. And they all had to come together at the same time."

Karen Buxbaum: "The people who come to work at JPL would do this as a hobby if they could."

One of the complexities was building a spacecraft, half of which spun and half of which didn't, that also had an atmospheric entry probe attached. Landano says, "I didn't fully appreciate early on that this design was an order of magnitude more difficult than Voyager."

Still, says Bill O'Neil, "I never once gave a thought to leaving Galileo to do anything else. From the beginning it was a commitment to the project. [We thought] 'This is the greatest thing we have going, and we've got to get the job done.'"

Those early years were full of near-constant change. Galileo began life as a direct flight from Earth to Jupiter, courtesy of the Shuttle-Inertial Upper Stage (IUS) combination. However, in those days the Shuttle was still awaiting the successful test of its main engines. The IUS was only a concept, not an operational upper stage.

By the time the Shuttle's first launch was postponed in early 1980, it was becoming increasingly clear that one Shuttle flight might not be enough to lift Galileo into orbit. The project reprogrammed their mission to fly the probe on one Shuttle flight and the orbiter on another, each using a three-stage IUS. In 1981, the agency reprogrammed the mission again, this time recombining the probe and orbiter, but placing them on a wide-body Centaur liquid-fueled upper stage.

Going from an IUS to a Centaur meant that working relationships had to change as well. Boeing, the Marshall Space Flight Center and the Air Force were out; General Dynamics and the Lewis Research Center were in.

"All the reprogramming was somewhat frustrating," Spehalski recalls. "Every time we thought we had developed a design and a working relationship, the reprogramming would knock down that house of cards and we would have to start over. We just swallowed hard and kept looking for a way to get the mission going on a path that would finally get us to completion."

The launch date slipped a few more times in the early 1980s, each time stretching the required lifetime of the spacecraft components. Then, in January 1986, came the Challenger accident. At the time, Galileo and its Centaur upper stage were at the Kennedy Space Center undergoing final testing for a planned May 1986 launch. But in the wake of Challenger the Shuttle Centaur stage was canceled, and a two-stage IUS became Galileo's new upper stage. The following year, the VEEGA trajectory was introduced as the best, if not the shortest, way to Jupiter.

Matt Landano, who was at that time the spacecraft system engineer, remembers that the shift to VEEGA presented a "major, major challenge, mainly because we already had a design and a built spacecraft." Among other things, the thermal design had to be changed to account for the fact that now Galileo would be traveling inward toward the Sun, where it would be exposed to twice the solar energy for which it originally was designed.

Jim Erickson: "We know we can fly encounters."

Nevertheless, the team set about rebuilding, retesting and reconfiguring the spacecraft. They added devices, removed others, disconnected still others. "And that was just the hardware," Landano says. "The existing, well-tested flight software had to be changed significantly to accommodate VEEGA, the spacecraft mods, and the new two-stage IUS."

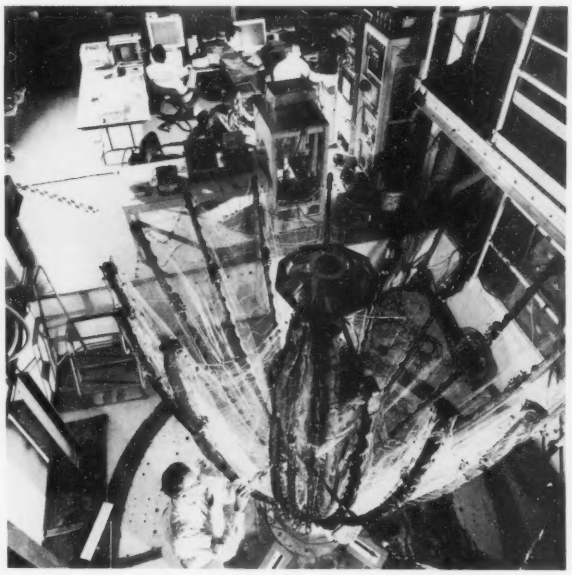
Engineer Jim Hoffman says that the thermal redesign also created new concerns for Galileo's large,

umbrella-like communications antenna. The antenna, which originally had been planned to open right after the firing of the Centaur upper stage at the start of the mission, now had to remain closed to protect it from the heat of the Sun near Venus and to preserve the integrity of the many epoxy bonds that held critical parts together and controlled the antenna's shape.

While the engineers wrestled with these concerns, project scientist Torrence Johnson and the other members of the science team had their own worries about the redesign, the delays and whether they could keep their graduate students onboard through all the schedule slips. The Galileo science group started out in 1977 as a fairly tight team, some of whom had participated in Viking and Voyager. That early team spirit was heightened during the late 1970s and early 1980s when the project ran a somewhat rocky course through the halls of Congress, even facing cancellation on a number of occasions. Johnson recalls that many of the science working group meetings were held under a banner that read, "The Force Is With You."

Through all the shifts and delays (the launch itself slipped seven years from the original planned date) the science mission at Jupiter remained essentially the same, thanks in part to Galileo's new, "smarter" software. Building on what had been learned during the planning for Voyager, the Galileo software engineers developed tools that allowed them to deal with an unpredictable future.

"One thing we did was decide on what basis we could make late changes to the flight sequences," says Galileo Science and Mission Design chief Jim Dunne. "In other words, we know the Jupiter atmosphere is dynamic. If you plan two years in advance to observe a certain feature, it might not be there. What we did was design windows in the sequences, within which we could move observations to accommodate late changes."



Engineers at JPL work with Galileo's Earth-bound engineering twin.

Finally, on October 18, 1989, Space Shuttle Atlantis roared into the sky with Galileo and its upper stage stowed safely in the payload bay. That same evening, the IUS fired to send the spacecraft inward toward the Sun, and the mission was at last underway.

Dick Spehalski, the project manager at the time, says that launch day was an emotional experience: "This intense focus of 12 years of hard work creates a powerful feeling. It's so strong."

On the day of the launch, he says, "There are just thousands and thousands of things which go through your mind....You know we had problems right up to launch. You're never sure you caught them all. We know one that got us, and we're not sure why it got us."

Spehalski refers, of course, to what may be the project's biggest challenge to date—the failure of Galileo's large communications antenna to deploy properly. In April 1991, 18 months after launch when the craft was safely outside the warm inner Solar System, the high-gain antenna was commanded to open for the first time. But three of the antenna's 18 graphite ribs failed to unfold, leaving Galileo without a means to transmit data at high rates.

No one was more surprised at the failure than antenna engineer Jim Hoffman. "I was so confident," he says. "I knew that antenna inside and out. I had worked with it daily....I supervised all the technicians who performed the modifications and testing and finally buttoned the thing up. We had deployed its engineering twin so many times. We knew everything there was to know about what could possibly compromise its proper deployment. When it didn't open it was really a shock, because nobody had any feel as to why."

The Galileo engineers have a better feel now, after analyzing the

situation onboard the spacecraft and spending literally thousands of hours in the engineering laboratory up the hill from the Galileo project offices at JPL. An anomaly investigation team has engineered several possible "fix it" procedures, some of which have already been tried, and some of which await further testing. In the meantime, the much slower rate low-gain antenna has been used to return images and data from Gaspra, Earth and Venus.

The project team has attacked this latest setback in the same way it's dealt with all the previous upsets: by digging in and working on several plans simultaneously. If the high-gain antenna has unfurled by next spring, the project managers will simply continue with the plan already in progress, which calls for the orbiter to return nearly 50,000 pictures as it tours the planet and its moons. If the antenna hasn't unfurled by then, they will switch to an alternate mission design that has been under study for the past year.

The alternate mission retains much of the richness of the original plan, and the goals at Jupiter are still the same. The atmospheric probe data still accounts for 25 percent of the mission science, and even though the orbiter won't be able to provide as many photos, it still will come much closer to Jupiter's moons and remain much longer in the Jovian system—two years—than did Voyager. Observations of the moons, the Jupiter atmosphere and the planet's magnetosphere still are scheduled. In fact, says Jim Dunne, the team believes "We can get something like 70 percent of our science objectives out of the data," even if the high-gain antenna never does unfurl properly.

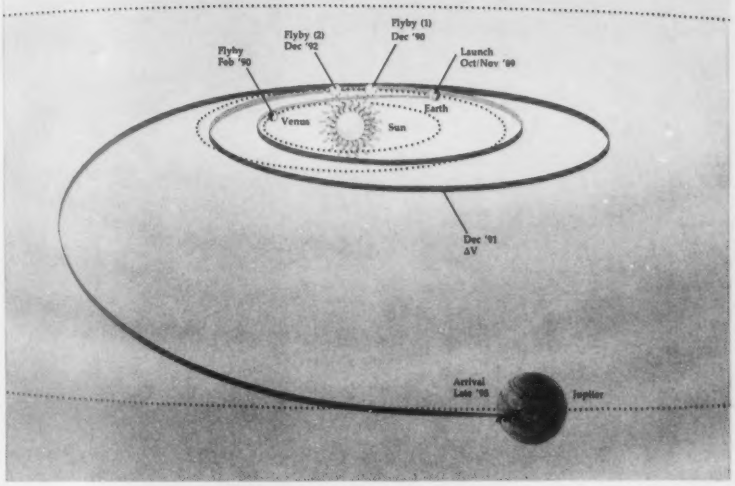
Getting that kind of return when the transmission rate drops to less than one percent of the planned rate is testimony to the Galileo team's ability to make the best of whatever situation is handed them. As Erickson says, "Being smart gets you ready to be lucky."

Karen Buxbaum is a relative newcomer to the Galileo team, having arrived at JPL in 1989. As chief of the science requirements and operations planning team, she's one of many people still scrambling to get even more return from fewer bits of data. Buxbaum says of her colleagues at JPL, "The people who come to work here would do this as a hobby if they could."

As for resolving the antenna issue and fulfilling Galileo's mission, she says, "However we do it, it's going to be firstclass. Everyone's stepping up to an incredible challenge. No one will accept less than a first-class effort." •

Charles Redmond is a contributing editor to the magazine.

The Long and Winding Road



October 1989 Galileo launched from Space Shuttle Atlantis

February 1990 Fly-by of Venus at a distance of 9,300 miles

December 1990 First fly-by of the Earth and Moon at a distance of 620 miles

October 1991 Galileo flies past Gaspra for the first-ever reconnaissance of an asteroid

December 1992 Second fly-by of Earth, at a distance of 200 miles, gives Galileo the energy it needs to reach the outer Solar System

August 1993 Galileo flies past the asteroid Ida on its way to Jupiter

July 1995 Galileo probe and orbiter separate to approach Jupiter on separate paths

December 1995 Probe plunges into the Jovian atmosphere, while the orbiter begins a two-year program of observing the planet and four large moons

Small, Quick

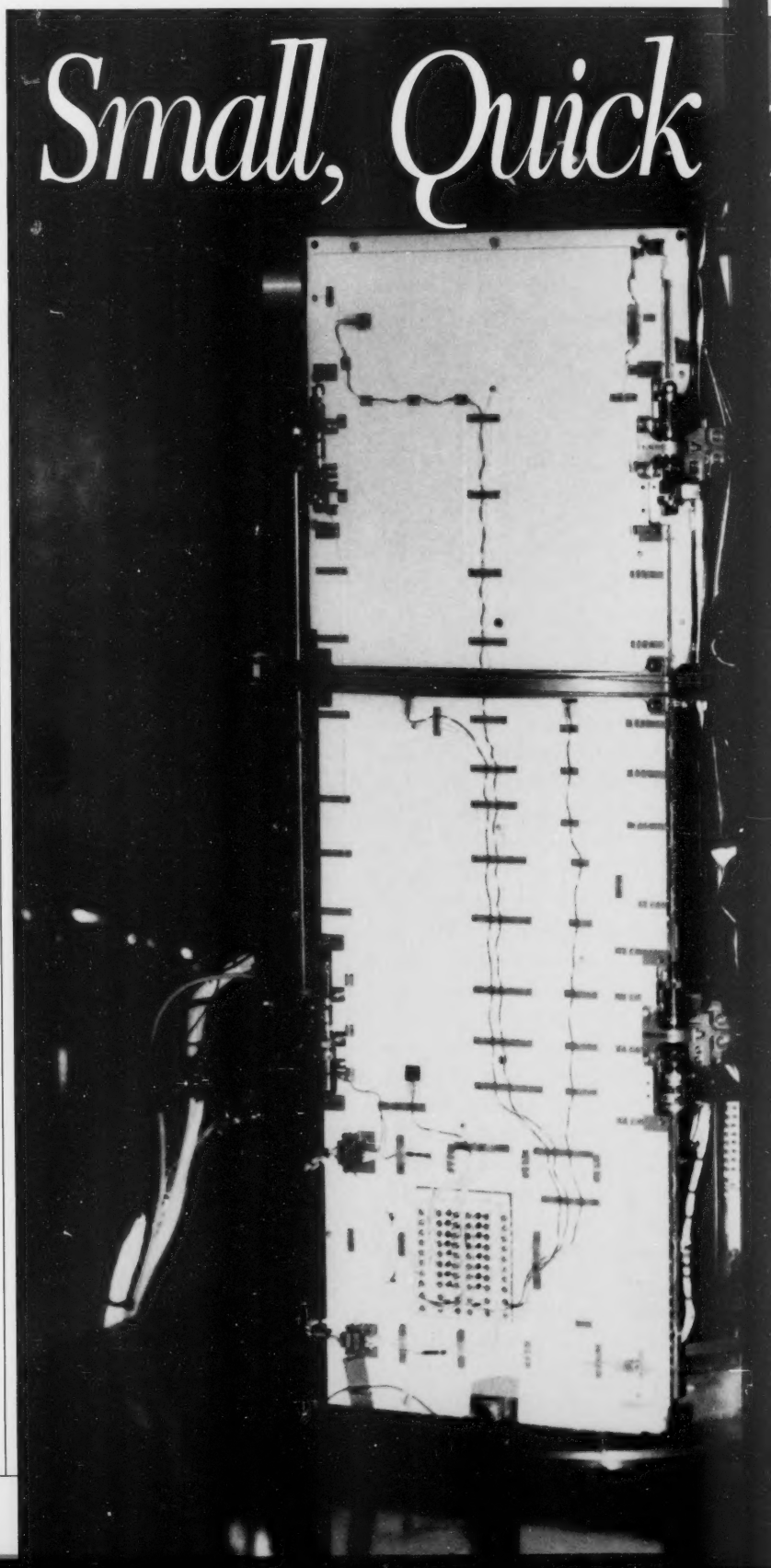
Sometimes it's easy to forget just how small the space program started. Sputnik 1 was hardly bigger than a basketball, and the first U.S. satellite to reach orbit, Explorer 1, weighed only 10 pounds. Since then, of course, space missions have grown by orders of magnitude in terms of size, complexity and expense. Now, in these tough fiscal times, NASA is once again thinking small. The most recent product of the "small, quick and beautiful" philosophy is the Small Explorer program managed by the Astrophysics Division of the Office of Space Science and Applications.

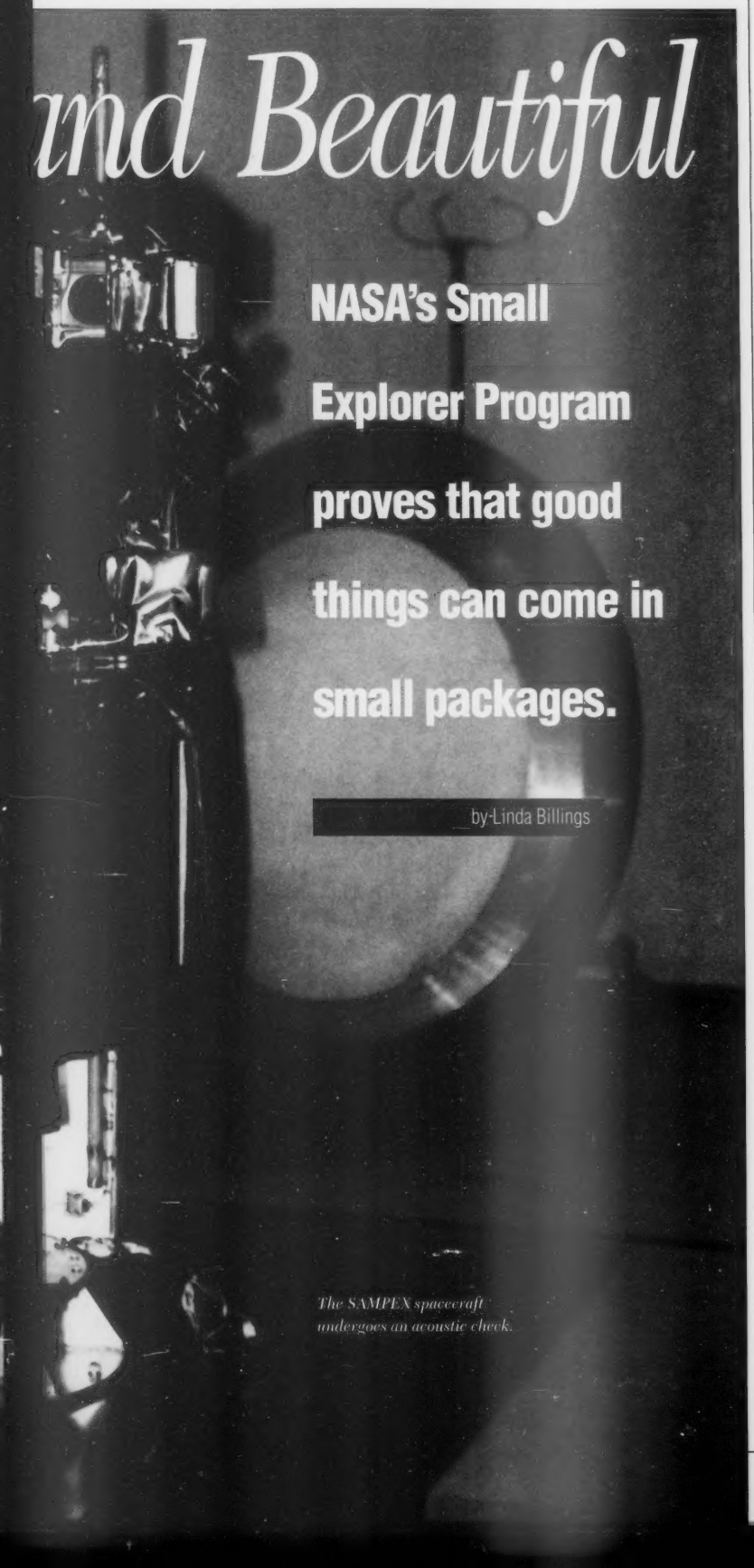
Small Explorers were conceived as a way to get high-quality space science data quickly, using low-cost spacecraft launched by expendable vehicles. A Small Explorer loaded with instruments is roughly the same size and weight as a refrigerator (about 180 kilograms, or 400 pounds) and costs about one-tenth as much as a larger-scale, Delta-class mission like the Cosmic Background Explorer. Small Explorers can be used for research in astronomy, relativity studies, space and solar physics, and atmospheric studies. They can address questions raised by earlier investigations, or complement other studies going on at the same time, or even help determine whether a larger mission is necessary.

In terms of cost and complexity, the missions fall somewhere toward the low end of a continuum that ranges from sounding rocket and balloon experiments to medium-sized Explorer missions to billion-dollar, multi-spacecraft initiatives like the International Solar Terrestrial Physics Program.

Perhaps most important of all, Small Explorers require only three years to develop. Not only do low costs and short development times encourage innovation, they also mean more frequent flight opportunities: The goal is to launch a Small Explorer mission every year.

The program already is off to a good start. The first mission in the series—the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX)—launched on





nd Beautiful

NASA's Small Explorer Program proves that good things can come in small packages.

by Linda Billings

The SAMPEX spacecraft undergoes an acoustic check.

time and within budget ($26.7 million, including instruments) last July, and the satellite is now returning data from orbit.

In a letter to NASA Associate Administrator Lennard Fisk written six months before the launch, SAMPEX principal investigator Glenn Mason, a professor of physics at the University of Maryland, praised NASA's ability to produce "a new, custom spacecraft…in less than three years from selection." In particular, the Small Explorer project's approach to quality control had been "a breath of fresh air," Mason wrote, "especially in the electronics parts area, where the project has allowed experimenters to use their own judgment with only advisory comments from Goddard….The future will be bright if you keep the emphasis on simplicity, short queues [and] risk tolerance."

Much of the credit for this "lean and mean" approach goes to the engineering team at Goddard Space Flight Center that built the SAMPEX spacecraft (science instruments came from Germany's Max Planck Institute for Extraterrestrial Physics, the Aerospace Corporation, the University of Maryland and the California Institute of Technology). Two notable features distinguished the Goddard SAMPEX engineers: their relative youth (most were under 30) and the enthusiasm and commitment of their two leaders, Small Explorer project manager Orlando Figueroa and SAMPEX mission manager Gilberto Colón.

Figueroa and Colón say their interest in the space program dates back to their school days. The two met as undergraduates at the University of Puerto Rico in Mayaguez, where they majored in mechanical and chemical engineering. As graduation approached, they both arranged interviews with a NASA recruiter visiting the campus. Figueroa got an offer and started work at Goddard in 1978. Colón got an offer, not from NASA but from the Department of Defense, and in 1979 he took off for a job in Cleveland.

A year later, Colón decided to visit

Figueroa for the Fourth of July. At the time, Figueroa was working in Goddard's cryogenic and fluid systems branch. He knew of a job opening, and he recommended that his friend pursue it. By December 1980, Colón was on the job at Goddard.

The two friends work well together, and they share the same management philosophy. "The key is respect," says Colón. The SAMPEX team members "understood that we had a goal, and the only way to achieve it was by working together."

One thing Figueroa was absolutely firm about was meeting the June launch date for SAMPEX, and he told his team so. "It wasn't always smooth sailing," he notes. But the team weathered problems and conflicts, like any close-knit family. By October 1991, eight months before launch, they were putting in long hours, seven days a week. Figueroa says he spent time each day walking around and talking to people, not only to see how the work was going but also to gauge morale.

The tight schedule was tough on families, and it wasn't unusual to see SAMPEX people bring their children to work on weekends.

The SAMPEX engineers worked through the Thanksgiving holiday, and at least one member of the team, electrical engineer Gary Cooper, worked through Christmas, too. The tight schedule was tough on families, and it wasn't unusual to see SAMPEX people bring their children to work on weekends. Over the course of three years, the project even celebrated the birth of a few "space babies." Anisa Ahmad, the lead engineer for the spacecraft's power system, worked through the early stages of contractions, staying on the job until two days before her child's delivery. She was back at her post just a few days after the birth. Instrument manager Roberto Aleman's wife delivered twins only five days before the first launch attempt on June 16.

SAMPEX team members left to right are Haydee Maldonado, Roberto Aleman, Rosa Aceredo, Gilberto Colón, Madeline Butler, and Ron Kolecki.

The Science of SAMPEX

As it circles the Earth, SAMPEX studies the variety of cosmic rays that strike the spacecraft and its onboard detectors. Cosmic rays aren't a form of energy like x-rays or gamma rays, but are particles of matter. They arrive in the vicinity of Earth from other parts of the Solar System and the galaxy, moving in all directions through space. Scientists are interested in learning more about the chemical composition, history and transport mechanisms of cosmic rays in order to better understand the violent processes by which they are created.

The SAMPEX instruments detect four different kinds of cosmic rays:

Galactic cosmic rays (GCRs) with energy levels as high as tens of billions of electron volts and velocities as high as 70 percent of the speed of light (other GCRs move even faster, approaching the speed of light);

Anomalous cosmic rays—atoms of interstellar matter accelerated by the shock wave that forms when the solar wind collides with the interstellar medium. These travel at 10-15 percent of the speed of light;

Solar energetic particles produced by violent processes on the surface of the Sun, which travel at about three percent of the speed of light; and

Precipitating electrons that fall out of Earth's magnetosphere and into the atmosphere. These particles are of interest for a number of reasons: They tend to peak when solar activity is at a minimum, and they also appear to play a role in the destruction of ozone in Earth's upper atmosphere.

The instruments on SAMPEX are 10 to 100 times more sensitive than any similar instruments flown to date. To record the data from these four detectors, SAMPEX is equipped with the new Small Explorer Data System (SEDS) developed by Goddard and built by Fairchild Space. The SEDS system uses 26 megabytes of solid-state computer memory instead of tape recorders to store engineering and science data for transmission to the ground. The system is cheap, lightweight and highly reliable. It also uses standard interfaces that allow all the spacecraft's subsystems to communicate through a common network using a common language—a simplified approach that may be useful for bigger NASA missions as well.

—Linda Billings

A favorite story of the SAMPEX team involves parts engineer Bryan Fafaul. Just when the project needed some crucial pieces of equipment, the vendor who made the parts came under investigation and its inventory was impounded. At that point, delivery of the parts already was a few months behind schedule.

"Needless to say, we were going nuts," Figueroa says. He started calling the vendor's chief executive officer regularly, even paging him on the golf course. Finally the vendor agreed to ship some of the equipment, and Figueroa put Fafaul on a plane, telling him not to come back until he had the hardware in hand.

Leaving his wife and a brand-new baby at home, Fafaul set off to get his precious parts. Every day for three days, he waited at the company's front door from 6 am until well past closing time, until he got the company to cough up the hardware. Figueroa proudly tells the story as an example of "people doing whatever it takes" to get the mission launched on time.

Now that SAMPEX is in orbit, Colón is considering his career options. One is to take on another Small Explorer mission (two more already are in the works—the Fast Auroral Snapshot Explorer (FAST) planned for launch in 1994 to study the physical processes that create auroras, and the Submillimeter Wave Astronomy Satellite (SWAS) planned for 1995, which will study the nature of interstellar molecular clouds). Another option is to "graduate" from Small Explorers and move on to something bigger.

Figueroa says he's committed to launching the next two Small Explorer missions on time and under budget, and ensuring that the Small Explorer project approaches the goal of one launch per year. With characteristic determination, he says, "I will stay here until that is done." •

Linda Billings is a senior writer for BDM International supporting NASA programs. Her last article for the magazine, on space technology spinoffs, appeared in the Winter 1992 issue.

So That's What They Do at NASA...

Students participate in the SAMPEX mission through the Cooperative Satellite Learning Project.

Fifteen-year-old Shawn Kelly took an unusual vacation this year: He visited Vandenberg Air Force Base to watch the launch of the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX), a project he had worked on for two years. He knew the ins and outs of the mission, why it was developed and what it was going to study. And just like the NASA engineers who built the spacecraft, his heart was in the pit of his stomach as he watched the Scout launcher lift off with SAMPEX onboard July 3.

Kelly and 20 other students from Laurel High School in Laurel, Maryland, have been actively involved in the SAMPEX mission through the Cooperative Satellite Learning Project (CSLP). Designed to motivate students of all ages to consider careers in the space industry, the pilot project is sponsored by the Goddard Space Flight Center, Allied Signal Aerospace Company's Bendix Field Engineering Corporation, and several other businesses and associations in the metropolitan Washington, D.C. area.

In 1989, Mike Fatig of Bendix, a flight operations manager at Goddard, conceived of the project after attending a career day at Laurel High School. Enamored with the students' enthusiasm, he wanted to help channel some of that energy into the space program. "People are our product," he says, "and we need to invest in that product."

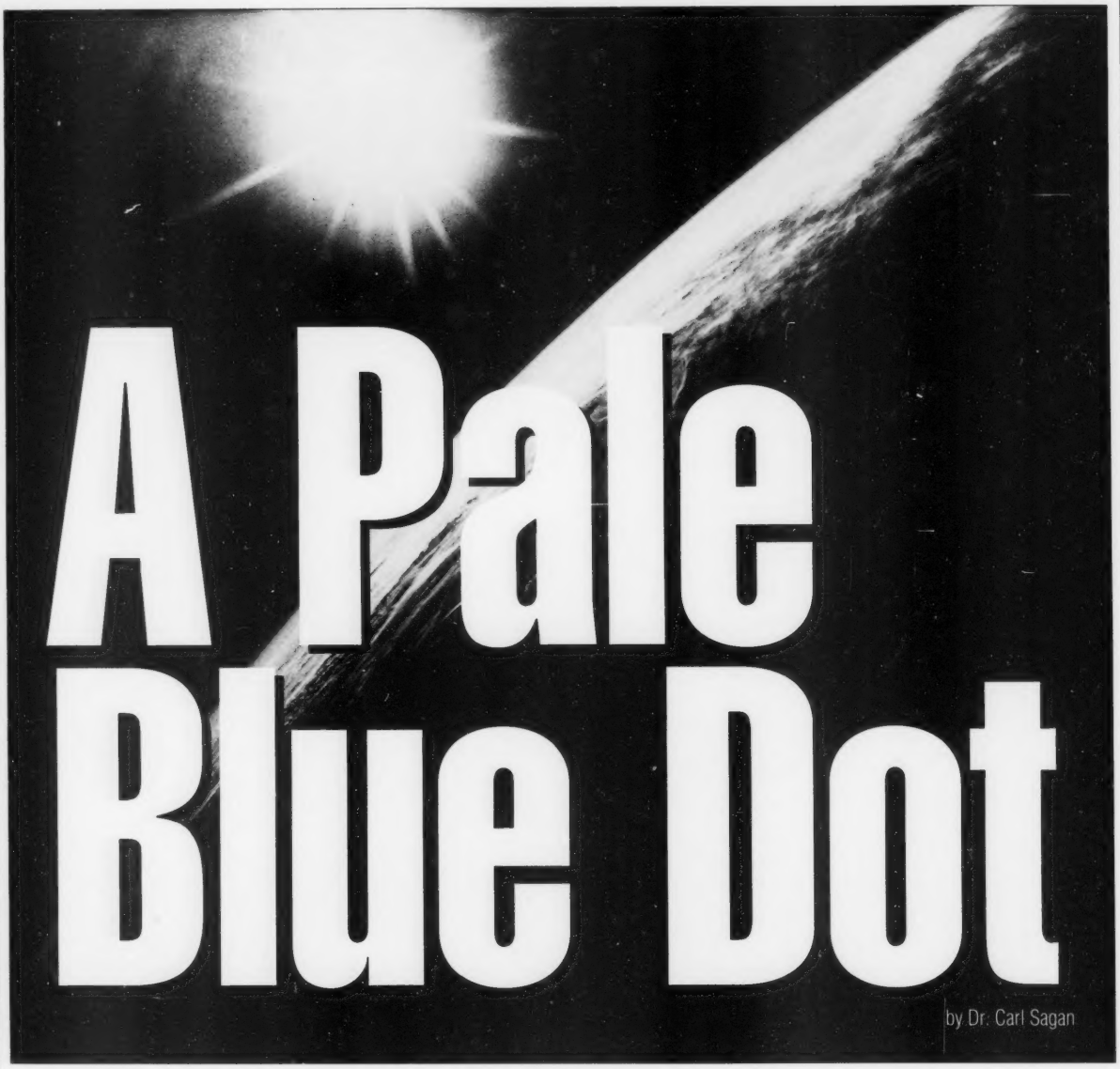
The CSLP, which kicked off in January 1991, has four phases that are similar to the steps NASA follows when preparing a spacecraft for launch. Phase One is lecture and discussion; Phase Two, system development; Phase Three, test and simulation; and Phase Four, operations. Each phase includes hands-on work at the school or at Goddard, as well as seminars presented by guest lecturers who visit the school. The only requirement for students to participate is that they have an interest in space.

The CSLP has been so successful that both Fatig and Goddard received a citation from Maryland Governor Donald Schaefer for their work on the project. Plans for a similar program linked to the next Small Explorer mission—the Fast Auroral Snapshot Explorer (FAST) scheduled for launch in 1994—already are underway at Berkeley High School in California.

As Laurel tenth grader Natalie Little attests, "CSLP has given me more respect for what NASA does, and it shows me that NASA is more than just launching rockets....Now I see that they are also trying to better our future."

—Karen Reinbacher

Karen Reinbacher is a writer for BDM International supporting NASA programs.



A Pale Blue Dot

by Dr. Carl Sagan

As seen from Earth orbit, our planet looks large; from Voyager 2, it looks like a pale blue dot.

The following questions about space exploration were posed to Cornell University planetary scientist and writer Carl Sagan during an interview by Claire Marino last spring, for use in NASA's exhibit at the World Space Congress in Washington, D.C. in September. —Editor

Q. What do you think mankind's perception of space was like before we sent spacecraft and humans up there to find out?

A. It's the most natural thing in the world to think that Earth is not only the center of the solar system, but the universe—put there for our edification or amusement. That has been the view of people all over the world, all through human history. And even today, even this minute, it is still with us. We talk about the sun rising and the sun setting. There's nothing in our language to indicate that it is, in fact, the Earth that's turning. I think that while most people had been taught that the Earth is round, in their heart of hearts they didn't believe it. And it was only after the advent of space exploration and in

particular, the early photographs of Earth— mainly from manned missions—looking back and seeing it as a beautiful blue-white jewel set against the black velvet background of space, that people suddenly got a sense of where we are.

Q. Can you remember the particular shift in consciousness that occurred when mankind first saw itself from space?

A. Suddenly people were struck in the most direct way with a portrait of their planet taken from outside. Nothing like that had ever been seen in human history. Now these pictures of Earth are a kind of global icon. You see them everywhere; we have become a little bit habituated to them. But of course, the wonder is there again with each new generation.

Q. I know that for the general public it was very important for us to get that view of Earth, to have that ability to look back on it. Is there a difference in the way the scientific community feels when something like this happens?

A. Well, you know, scientists are human beings also, and so naturally they get caught up in the passions and prejudices of the moment just like everybody else. The sense of wonder in looking at Earth from space, I believe, is shared as much by scientists as by the general public. And what a triumph for the human species to be able to step off the Earth and look back at ourselves. The most profound example, I believe, was obtained by Voyager 2; after passing the outermost planet, we were able to turn the cameras to photograph the Earth. A single pale blue dot. No continents, no clouds, no oceans. Just a pinpoint of reflected sunlight! All those billions of miles away. I find that a chilling, spine-tingling, exciting, perspective-raising, consciousness-raising experience. It's said that astronomy is a humbling and character-building experience. This is an example of it.

Q. I wonder if in some ways the fascination of looking back at Earth is one of the most important benefits of having gone to space.

A. It's one of the most important intangible benefits. Hard to put a price tag on it—unlike so many of the benefits of space exploration.

Q. I wonder if you could talk about humankind's urge to explore?

A. It's deeply built into us—after all, we come from hunter/gatherers. Humans spent 99% of their tenure on Earth, before civilization, in small nomadic groups. And so we were always exploring. Exploration is built as deeply into us as anything. Now, for the first time, we are in this circumstance of living in a world in which almost everything except the ocean bottom is explored. We've been almost everywhere, we humans. And so this urge for exploration has no outlet—except that at just this same moment, the universe has opened up to us. Now we have a much vaster arena for our exploratory propensities than the mere surface of one small planet circling one small star.

Q. What more is there to find out there? Why should we keep going out there?

A. First of all, if you buy my argument that exploring is built into us genetically, then there is no 'why,' any more than we ask why we humans enjoy being in each other's company. It's just the way we are. Still, I think the reasons for exploring are very concrete. The deepest one, to my mind, is that only by knowing what else is possible can we understand ourselves. If you're stuck on this planet, and you only know one style of volcanoes, or earthquakes, or climate change, or weather, or life, then you are fundamentally limited in how well you understand your own home.

Venus is a world with a horrendous carbon dioxide greenhouse effect, which has raised the surface temperature to about 470 degrees centigrade. That's roughly 900 degrees Fahrenheit. That's hotter than the hottest household oven. It is important for us to understand that a massive carbon dioxide greenhouse effect can have such a consequence—we who are busily pouring carbon dioxide and other greenhouse gases into our own atmosphere. Go to Mars, and not only can't you find big forms of life, you can't even find microbes. You can't find the simplest organic molecules. Why? Because Mars has a planet-wide ozone hole. There's no ozone on Mars. The searing ultraviolet light from the sun strikes the surface unimpeded, and any organic molecules that were there get quickly fried. Isn't that information of use to us who are tearing holes and thinning our ozone layer? That's a very practical application of planetary exploration. •

Jay Honeycutt, KSC's director of Shuttle Management and Operations.

Kennedy

Measured Results

Last year, for the first time in the history of the Shuttle program, the number of flights manifested for the year actually was flown. "That's something we all ought to be proud of," says Jay Honeycutt, director of Shuttle Management and Operations at Kennedy Space Center. KSC's Lisa Malone reports that according to Honeycutt, the Shuttle processing team has achieved impressive results over the last few years. Records show that the KSC team is learning to do things more efficiently and to reduce the processing time needed to prepare Shuttles for flight.

"It has been a team effort, involving KSC, NASA Headquarters, Johnson Space Center, Marshall Space Flight Center, and our contractors," Honeycutt stressed.

Measured results clearly indicate an improvement in all phases of Shuttle operations, including a reduction in the number of components replaced on Shuttles, processing enhancements and trends in the number of requirements and changes per Shuttle flow. By combining tests where appropriate and deleting duplicate operations, the number of days an orbiter spends in the Orbiter Processing Facility has been reduced from 196 to 55. •

Marshall

Quick Turnaround

Seventy-one Marshall employees recently received awards for their efforts in developing an electrically conductive thermal control coating and applying the technique to retrofit flight panels on the Tethered Satellite that flew on July's STS-46 Shuttle mission. The effort was initiated after the Tethered Satellite System experienced a technical problem during testing, which indicated that the electrical resistance of the coating already applied to the satellite was rising to an unacceptable level.

The awards recognized the employees for

Marshall Director Jack Lee (left) presents Tethered Satellite Award to Melvin R. Carruth.

"developing, testing and qualifying a completely new paint formulation and establishing a viable approach for recoating flight hardware that would support the July launch"—all of which they did in a two-week period. The awardees included a management group of 14 employees and an implementation group of 57 employees. •

Lewis

PHOTO/TOM JARES, LeRC

"I'm living on the Red Planet....Not!"

Out of This World

Last May, 32 teams of northeastern Ohio elementary and middle school students "linked up" at Lewis to build inflatable habitats that together made up an entire Martian colony called "Marsville—The Cosmic Village." Marsville is part of the Challenger Center for Space Science Education's International Space Year Project.

Some of the students teamed up to create a system to control the temperature inside a Mars habitat. Other schools focused on areas such as communications, recreation, recycling and transportation systems. In designing their systems, the teams had to consider the amount of space available in the habitat. Lunches, for example, could weigh only 22 ounces, and students were encouraged to pack food in containers that could be recycled or used over again. According to the Challenger Center's Cleveland office coordinator, Luanne Bole-Becker, "The kids really took this project seriously." •

JPL

Partners

The National Technology Initiative Partnership between the Jet Propulsion Laboratory and three Department of Energy (DOE) facilities—Lawrence Livermore National Laboratory, Lawrence Berkeley Laboratory and Sandia National Laboratories—was announced in late May. The partnership is a cooperative effort of the laboratories to work together to help U.S. industry meet global technology-driven competitiveness challenges. Pictured from left to right, are Thomas Everhart, President of the California Institute of Technology; NASA Administrator Daniel Goldin; James Watkins, Secretary of the DOE; Al Narath, President of Sandia National Laboratories; John Nuckolls, Director of Lawrence Livermore National Laboratory; and Edward Stone, Director of JPL. •

Ames

A New Arrival

A new Mobile Research Facility (MRF) designed to play a major role in the Search for Extraterrestrial Intelligence (SETI) Microwave Observing Project/ Targeted Search has arrived at Ames. Larry Webster, project manager for the Targeted Search, says the facility will enable SETI researchers to operate at remote locations around the world.

The MRF will begin operation on October 12 at the Arecibo National Observatory in Puerto Rico. The Targeted Search will use the world's largest radio telescopes located in Puerto Rico, Australia, the United States and Europe to search among the 800 nearest stars for microwave emissions suggesting the existence of intelligent life elsewhere in the Universe. •

Stennis

More Satellite Images = More French Fries

The Stennis Space Center's Science and Technology Laboratory has helped potato farmers in Oregon to reap greater benefits from their potato crops—the largest vegetable crop grown in the United States. The potato crop is not a simple one to cultivate and market, so an Oregon farmer asked NASA if satellite remote sensing technology could be used to ease the fluctuations of the market. Stennis' Chuck Hill says, "By providing farmers with information about their crops, it helps them compete globally."

At the end of a three-year project with NASA, the farmer was able to use satellite data to improve the timeliness and accuracy of information regarding acreage, location and yield potential for the Columbia Basin potato crop in Oregon. The farmer developed a commercial product consisting of a series of reports delivered to other farmers during the growing season. Included are false color infrared images of the Columbia Basin showing the patterns of crop development at several stages and color-coded classification maps identifying the various crops and statistical summaries of potato acreage broken down by county. •

Johnson

Double Duty

When the EVA (Extravehicular Activity) branch of Johnson's Engineering Crew and Thermal Systems Division was given the job of qualifying the Shuttle spacesuit for duty outside Space Station Freedom, they jumped to the task. Glenn Lutz, subsystem manager for the extravehicular mobility units (EMU), said current plans call for about 12 space walks to maintain Freedom before the suits would be returned to Earth for servicing. If for some reason a cycle were missed, the number could reach 25 over a 180-day period. "We needed to go prove to ourselves we can do twice that," said Lutz.

Lutz worked with a team of 25 engineers, technicians, test directors and console operators from Hamilton Standard and Lockheed to test the suit's primary life support system (PLSS). When the second set of laboratory tests ended in July, one PLSS unit had accumulated a total of 100 test runs and 800 hours of work without an overhaul. As one engineer said, "I'd climb in it right now and go EVA!" The next step in qualifying the suit for duty on Freedom is to conduct similar tests with the spacesuit itself.•

In a time of scarce budgetary resources, it seems clear that international cooperation is more important than ever for NASA. James Zimmerman, the agency's European Representative, gives us the perspective from "over there."

PHOTOBILL INGALLS, HQ

Sharing the Dream

by James V. Zimmerman

NASA has been working cooperatively with space agencies around the world for more than 30 years. The extent and value of this cooperation has grown—we are currently pursuing some 200 projects with agencies in 28 countries— and we can expect even more joint ventures in the future. Several trends offer clues as to how this future cooperation will be structured:

New Partners: The break-up of the Soviet Union and the establishment of space programs in Russia, Kazakhstan and the Ukraine have ushered in an era of unprecedented opportunity and uncertainty for NASA and the other space agencies around the world. Establishing new relationships with old rivals is an exciting challenge, and our current efforts are laying the groundwork for what may become long-term, mutually beneficial associations with revitalized Russian and other former Soviet space organizations.

Changing Industrial Roles: In the past, space industries around the world generally played a supporting role in their governments' space programs, producing hardware and providing needed support. Today the role of industry is changing. Global markets have encouraged international mergers and strategic alliances, and space industries around the world are increasingly active in initiating and shaping prospective cooperative relationships between governments.

Greater Political Feedback: Events in the U.S. often have had significant impacts on the space programs of our partners. The Challenger accident set back space activities around the world, and recent U.S. Congressional debates on the future of Space Station Freedom are having an impact on our partners in Canada, Europe and Japan. When we succeed, they succeed. But the feedback goes both ways. Cuts in projected spending on space in Europe, for example, may have an impact on NASA's current and future programs.

Growing Pragmatism: When possible, space agencies around the world have preferred to conduct their programs without substantial foreign involvement. Now, however, tight budgets are giving rise to greater pragmatism in Europe, the U.S. and elsewhere. When confronted with the need to scale back its plans for human space activities, Europe chose instead to seek greater international participation. NASA may find itself making similar choices on key programs.

These developments and other less specific changes in our international relationships will occur as NASA itself changes to meet the challenges of the 1990s. Partly because the agency adapts so well to change, NASA remains the partner of choice for most other space agencies around the world.

But our partners also are anxious to know whether NASA is open to *real* sharing, and to forging new cooperative relationships where non-U.S. partners make contributions that are essential to a mission's success. These "critical path" contributions, our partners feel, would give added assurance that NASA trusts and values their role.

The sharing of critical path roles already has occurred in some NASA programs. In many others, however, it hasn't been considered. As NASA pursues its goals in an era of scarce fiscal resources, mature partnerships involving critical path contributions from abroad could make an important difference. We must forge such partnerships carefully, of course. But we can't afford to ignore the opportunity to do more together than any one country can do alone. The time has come to consider sharing the dream. •

James V. Zimmerman serves as NASA's European Representative stationed in Paris.

LAUNCHES

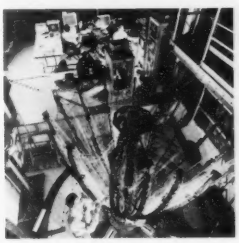
• STS-53—the Space Shuttle Discovery will deploy the classified DOD-1 payload.

• STS-54—the Space Shuttle Endeavour will deploy TDRS-F on orbit 5.

EVENTS

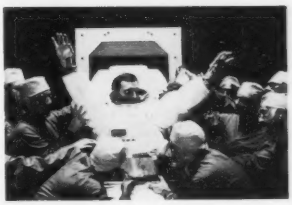
1
DECEMBER
Technology 2002 Conference and Exhibit in Baltimore, MD.

8
DECEMBER
Galileo Earth fly-by.



IN OUR NEXT ISSUE

Presenting...Space Center Houston!



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